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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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PUBLISHERS' ANNOUNCEMENT: REMOVAL OF THE OFFICES OF THE JOURNAL.

The proprietors of the JOURNAL herewith announce that the publishing offices are now located on the sixth floor of No. 42 Pine street, which building is just below the one occupied by the JOURNAL since 1891. The JOURNAL's new quarters (in reality they are old ones, for its publishing offices were maintained in the building that formerly covered the site of 42 Pine street from May, 1870, to May, 1891) are in a modern structure that is located in the heart of the financial business section of the city, and can be reached easily by or from any of the main lines of public travel. A. M. CALLENDER & CO.

[OFFICIAL NOTICE.]

Twenty-Fifth Annual Meeting, Western Gas Association.

WESTERN GAS ASSOCIATION,
OFFICE OF THE SECRETARY,
NEW ALBANY, IND., April 7th, 1902.

The Twenty-fifth Annual Meeting of the Western Gas Association will be held May 21st, 22d and 23d, 1902, in the New St. Charles Hotel, New Orleans, La., and will be called to order, at 10 A.M., by the President, Mr. Thos. D. Miller, of Dallas, Tex.

The Executive Committee has arranged for the presentation of the following papers:

"Experiments on Bench Fuel;" by Mr. W. A. Baehr, Denver, Col.

"Gasholder Specifications;" by Mr. H. A. Carpenter, Allegheny, Pa.

"Electrolysis;" by Mr. Jno. M. Humiston, Chicago, Ills.

"Beaumont Oil for Gas Making;" by Mr. Jno. H. Fitzgerald, Houston, Tex.

"Some Experiences in New Orleans;" by Mr. Bankson Taylor, New Orleans, La.

"Gas Engines;" by Mr. C. H. Nutting, Chicopee, Mass.

"Distributing Gas at High Pressure;" by Mr. Geo. F. Goodnow, Waukegan, Ills.

"Current Purifier Practice, and a New Form of Construction;" by Mr. F. H. Shelton, Philadelphia, Pa.

"Wrinkle Department;" edited by Mr. W. E. Steinwedell, Belleville, Ills.

A paper by Mr. B. E. Chollar, St. Louis, Mo.

The New St. Charles will be the Association headquarters. Rates for those attending will be as follows:

American plan: Two in room, $2.50 per day, each person; $3 per day one in a room. Rooms with bath, $3.50 per day and up.

European plan: Two in a room, $1 per day, each person; $1.50 per day and up, one in a room. Room with bath, accommodating two persons, $4.

Also, rates may be obtained from the Hotel Grunewald, Cosmopolitan and Denechand, as follows:

Grunewald: Strictly European, in connection with which there are two restaurants—Single rooms, $1 per day for each person occupying same. Room with bath, $2.50 per day.

Cosmopolitan: European plan, $1.50 per day and up.

Denechand: American plan, $2 to $3 per day; European plan, from $1 to $1.50 per day.

More satisfactory arrangements can be obtained by securing quarters in advance of meeting.

The New St. Charles Hotel Manager announces that they will have ample accommodations, except possibly that single rooms may be limited; but their double rooms will be satisfactory, as they are large and well located.

Reduced railroad rates of one-and-one-third fare for the round trip, on the certificate plan, have been obtained for members, their wives and all persons attending the Western Gas Convention, through the courtesy of the representatives of the following Passenger Associations, con-

MAY 12 1902

ditional on 100 persons being in attendance: New England Passenger Association; Southeastern Passenger Association; Southwestern Passenger Association; Trunk Line Passenger Association; Central Passenger Association; Western Passenger Association.

The districts covered by railroads comprising the above Associations are all the States and territory east of Cheyenne, Wyo., including Texas, Utah and Colorado, and the New England States.

To obtain rates on the certificate plan to New Orleans, apply to agent at least 30 minutes before time for departure of train, purchase a ticket, obtaining from agent a certificate stating that full fare has been paid to New Orleans, which certificate will entitle purchaser to a one-third rate returning to starting point, providing said certificate is handed the Secretary for the purpose of indorsement by the representative of the Passenger Association, who will be present Thursday, May 22d.

Some Western roads furnish certificates from junction points only. Members are, therefore, requested to consult local agent as to the place from which certificates can be obtained.

Persons living outside the territory embraced by the above Passenger Associations will purchase ticket to most convenient point within territory from which rates are applicable, and from there purchase ticket on the certificate plan to New Orleans.

Tickets as above can be purchased from and after May 17th, and are good returning, leaving New Orleans not later than May 27th.

Gas companies are solicited to send representatives to become members of the Association. The membership fee is $10, annual dues thereafter, $5. The Association publishes in bound volumes proceedings of its meetings. Copies when published are furnished free to members.

Queries for the Question Box, if mailed to the Secretary in advance of the meeting, will be assigned to members for answer.

Any information regarding the meeting will be gladly given by the undersigned. JAMES W. DUNBAR, Secretary.

[OFFICIAL NOTICE.]

Wrinkle Department, Western Gas Association.

WESTERN GAS ASSOCIATION,
OFFICE OF WRINKLE DEPARTMENT.
BELLEVILLE, ILLS., February 12th, 1902.

This department is now open and ready for contributions, which will be presented at the Twenty-fifth Annual Meeting to be held next May. The active co-operation of all members and friends is earnestly solicited. Please forward contributions to the Editor before April 15th.

W. E. STEINWEDELL, Editor.

BRIEFLY TOLD.

THE NEW ORLEANS MEETING OF THE WESTERN GAS ASSOCIATION.—All preparations that could be made for assuring the success of the twenty-fifth annual meeting of the Western Gas Association, to be held next week in New Orleans, have been made. The executive officers of the Association, as it was known they would be, were alert and resourceful, in respect of securing headquarters and meeting room, and the local committee promise an entertainment that will be well worth sharing. The technical part of the proceedings cannot fail to satisfy the members, in testimony whereof is Secretary Dunbar's listing of papers, as shown in the official notices. We fear that the unusual activity in the construction and reconstruction of gas works now going on in the East will somewhat curtail the attendance from this section of the country, and it is also likely that the Cincinnati convention of the National Electric Light Association, which is to be held on the days that the Western Association will meet, will also keep some gas men from going to New Orleans; but it is certain that President Miller will have a representative and numerous delegation to direct. In our advertising columns will be found a notice from Mr. Bankson Taylor, Manager of the New Orleans Lighting Company, asking those manufacturers who propose to take part in the tentative exhibit of gas appliances during the convention to let him know at once the amount of space they will require. The necessity of prompt action over this request is obvious.

NOTES.—Mr. F. W. Blowers, for many years in the service of the Detroit (Mich.) City Gas Company, has been appointed Manager of the Kalamazoo (Mich.) Gas Company.——At the annual meeting of the Pottsville (Pa.) Gas Company the following officers were elected: Directors, Robert Allison, William J. Matz, Frank Roseberry, B. W. Cumming, A. S. Faust, Charles Yuengling, Jas. Ziebach, H. T. Duke and G. M. Roads; President, Robert Allison; Secretary, E. H. Nice; Treasurer, A. S. Faust.——According to the annual report of Mr. Wm. P. Knowles, Superintendent of the Richmond (Va.) City Gas Works, the total output for the twelvemonth was 234,846,750 cubic feet; of that quantity the consumption on public account, for which no payment is made, amounted to 16,631,100 cubic feet. The excess of receipts over expenditures is returned at $88,307.18.——A syndicate of St. Louis capitalists have purchased the gas, electric and street railway systems of Paris, Tex. Mr. Thomas W. Crouch is said to be the controlling spirit in the movement. He is a resident of St. Louis.——The Bordentown (N. J.) Gas Light Company proposes to extend its mains to the adjoining borough of Fieldsboro.

[Prepared for the JOURNAL.]

The Relative Advantages of Cast Iron and Wrought Iron Gas Mains.

By MR. GODFREY L. CABOT, Boston, Mass.

I read with great interest the discussion, reported in your issue for April 14th, as to the relative advantages of cast iron and wrought iron gas mains.

Three years ago, I visited nearly every country in Europe, excepting Spain and Greece, studying this question; also, New York, Philadelphia and Pittsburg in this country. In every system of cast iron mains that was investigated, the leakage was incomparably greater than in our own wrought iron mains, which have a total length of from 60 to 70 miles, and handle from 9,000,000 to 10,000,000 cubic feet per day. After all due allowance for the fact that the conditions are very favorable in all the different places in which our mains extend, as compared with any one of the municipal plants which we visited, the weight of the evidence still remains very greatly in favor of wrought iron.

In the first place, wrought iron itself is impervious to gas; cast iron pipe is not. We have seen cast iron fittings bubbling where the gas came through them, and whenever a cast iron main is raised, after artificial gas has been passed through it for a considerable time, the surrounding soil smells strongly of gas.

Cast iron mains are usually put together with lead, and a lead joint does not work well. Any displacement of the pipe, or the mere effect of time, with the variations of temperature which are constantly taking place, and which affect differently two metals having a different coefficient of expansion, will loosen the joints.

Various rubber joints are in use in different parts of Europe; but, cast iron having a rough surface, and from the very process of manufacture not permitting of the same exactness in dimensions as wrought iron, it is impossible to sufficiently protect these rubber bands which form the joints from the oxidizing effect of the air, which is present in most soils; and in any considerable length of main put together with any of the various forms of rubber joints which we found in use in Europe, some portion will become leaky before many years are past.

Some years ago there was a terrible subway explosion in Boston, which would not have occurred if the mains had been made of wrought iron. The evidence showed that the mains had cracked, and wrought iron will not crack, whereas cast iron very frequently cracks, where subsidence takes place or a very heavy team goes over it.

Wrought iron is said not to withstand the action of the soil as well as cast iron; but I think this is fallacious. It is true that, in a given time, a larger proportion of wrought iron pipe will become oxidized under given conditions than cast iron pipe, but the oxidization of wrought iron pipe takes place evenly over its whole surface, whereas cast iron pipe becomes pitted and rusts through in one place.

It is true that wrought iron service pipes, unprotected, do not last as long as the cast iron mains to which they are connected, but they are not nearly as favorably situated. First, because they approach nearer to the surface of the ground; second, because they are exposed, at the curbstone and at the house wall, to exceptionally unfavorable conditions.

Where service pipes are swathed with a double thickness of cloth, soaked in soft coal tar pitch, there seems to be no limit to their life.

At the time that the subway was being laid in Boston, there was hardly a point for over a half a mile at which you could not smell gas as you walked along the street, and our system of gas piping in Boston is one of the most perfect in the world of cast iron pipe. We know of no other system in the world where there is a less percentage of gas unaccounted for, and we have made very particular inquiry in a great many different cities. This certainly shows that the present system is susceptible of improvement.

The relative first cost of the two kinds of mains varies in different localities. A few years ago wrought iron was decidedly cheaper in proportion to the size of the main, and it will probably be so again as soon as the competition to the present very powerful combination of tube manufacturers has had time to develop.

I am in favor of laying gas mains entirely of wrought iron, using as far as possible malleable fittings, and insisting on a good quality of cast iron for such fittings as cannot be bought of malleable iron. Second, every part of the system, for mains laid under paved streets or in bad ground, should be swathed in a double thickness of cloth soaked in coal tar pitch. You will then have a system that will be the most durable and the tightest that technology has yet discovered practicable for this purpose, and the saving in leakage and in the expense of repairs will in

most cases pay for the additional first cost, which may be roughly considered the labor in applying the protective covering.

I would not have it understood by any means advocating the tearing up of cast iron mains that are in fair working condition in order to replace them with wrought iron mains, but where extensions are made, or cast iron mains must be replaced, we advocate the substitution of wrought iron.

We have, as yet, not had to replace any of our wrought iron mains, although some of them are nearly 20 years old.

I think that, in good clay soil in unpaved streets, it will not generally be needful to apply any special protection, but where streets are paved, or there is an exceptional expense for digging them up, where the soil is loose, wherever a gas main passes through or near a sewer or a bed of cinders, or is exposed to water from some coal seam, it is better to protect them in the way described.

The is no great difficulty in using the two together, and in connecting the wrought iron main to the cast iron main, generally speaking, no especial appliance has to be used that cannot be bought in the open market.

I have seen a thin sheet iron pipe that had been in the ground 60 years, protected by a mixture of coal tar pitch and gravel; also, I may add, by a thin layer of lead, which, however, has very little effect. The pipe was just as fresh as the day it was put down. The weakness, however, of that particular system lay in the fact that the covering of gravel and tar was easily cracked, and wherever water entered it quickly destroyed the pipe. It is chiefly of interest to us as showing that where pipe is protected by tar there is no known limit to its life.

The mummies of Egypt are irrefutable evidence to us of the efficacy of this method of excluding air and water, for the bitumen in which the mummy cloths were dipped is precisely analogous in its effect to the much cheaper material which we propose.

There is one danger, however, from which, to the best of my knowledge and belief, this is not a defence: Namely, that of electrolysis. Where any considerable amount of electric current gets into a system of underground pipes there is no cure for this disease; the only thing is prevention. We know of no metal, save only the noble ones, that will not be corroded in moist earth with the electrical current, and where considerable current gets into the pipe it may melt off any protective covering that you can put on it. So, again, we think wrought iron pipe is at least as safe as the cast iron, for it at least gives you a continuous conductor. The corrosion does not take place where the electricity enters the pipe, but where it leaves it, and with the wrought iron pipe you can at favorable places lead off a portion, at least, of your electricity, by a chain into a stream of water, and corrode your chain or piece of old junk, instead of your valuable pipe. But in the case of cast iron pipe a portion of your electricity is likely to leave the pipe at any joint. and there the pipe will be pitted.

With regard to the comparative specific gravity of coal and water gas and natural gas, they overlap. There is some natural gas that has only a little more than 0.50 specific gravity, and some that has over 0.8; average about 0.600; but on an average, in this country, natural gas has a greater specific gravity than coal gas, and a lesser specific gravity than water gas.

The Function of Original Research in a Technical Education.[1]

By Prof. E. D. Campbell, of the University of Michigan.

Mr. President and Gentlemen of the Association: I deem it a special privilege to have an opportunity to speak to you to-day and to give you a few individual ideas in regard to the research work along the lines of interest to you. Although not at present actively engaged in practical work, I had 3 or 4 years' such experience before returning to the University.

When Mr. Douglas asked me to speak here before your Association on some topic, he allowed me to suggest the subject, and I suggested "The Value of Research Work in Technical Education," thinking perhaps I could bring a few ideas that might be helpful to the Association and to the University.

When we consider technical education we should look at it from the time technical education really began. A good many years ago there were practically no technical schools, in the modern conception of the term. All of the manufacturing industries which have grown so much within the past few years were trades rather than professions. The training of men was purely a matter of apprenticeship. Young boys went in where their fathers were, beginning at the bottom, doing the simplest kind of work, and gradually learned by rule of thumb to follow in the steps that their fathers had taken before them. The effect of such training naturally prevented to a great extent the development and expansion of the industries. There was little chance for the individuality of the man to show himself. He could not broaden out.

It was when this was realized that we began to get the technical schools established. In these technical schools were taught the elements of mathematics, drawing, engineering and such elementary work as any man about to engage in industrial work must have if he expects to make much progress. The institution of these technical schools was a great step in advance. If we look over the curriculum of the various technical schools in the country we will find, almost without exception, that the man who goes to those schools is taught fundamental work, which is already well known. He is taught from text books or by lectures accompanied with laboratory work demonstrating the points which are brought out in the lectures. But the ordinary student always receives his knowledge from his instructor, takes what he gets in that way, and does not develop his originality or his individuality. This, to my mind, is one of the weakest points in many of the technical courses; namely, that the work is almost completely confined to work which is already known about things already known. The result of this must be to make the men who study along these lines nearly of the same type; for they go through the technical schools, through the technical departments of some university, or whatever it may be, and there is the strongest tendency for these men to come out all molded into the same pattern. This system of instruction, while it is a great advance over the apprenticeship system, in which men get none of the general broad principles, and none of the knowledge of the well understood laws which underlie all our industries, is not, to my mind, at all the highest course which might be established.

I think that in any technical courses there should be introduced some research work. Where a man studies this fundamental work only he becomes narrow and accustomed to depend solely on what the instructors or text books say, and he does not acquire much independence. When a man undertakes research work and investigation he begins to strike out for himself. He undertakes research work under direction of someone who has been through similar work before; not the same work, but similar work. He learns, in the first place, when he undertakes research work to find out what has been done on this particular subject, whatever the subject may be. He learns to go back to the original sources of information. He does not take what has been condensed into some text book and assume that all that text books say is perfectly accurate; for, of course, a great many mistakes creep in. He does not assume that the writer of the text book has used the best judgment that could be used. for any author is liable to misinterpret the result of experimental work reported by other workers. He learns to set that work aside to a great extent and go for his information to the original publication of the experimenters on the subject under examination. He goes over the literature and gets this thoroughly digested. When he has thoroughly studied all that has been previously done upon the subject he begins to think for himself. He compares the results of these men and sees where the experimental work agrees, where there are inconsistencies, and, if possible, why there are inconsistencies. He begins, in other words, to use his own brain and to work independently. When he has begun to work and think independently, he then begins to encounter his difficulties.

A man who has not done the preliminary dead work that is necessary for any research has but little idea of the amount of labor connected therewith, or the patience that is required. Days and weeks, possibly months, of preliminary work is done, and when that is finished perhaps he finds an utter failure; that the system of working will not bring about any results and he must start over. He begins to meet those difficulties and he must think about them and learn to overcome them. He must depend upon himself; depend on his own individuality and his own ability to meet and overcome those difficulties. This is one of the greatest values of research. It helps to make a man of him, and a man who can meet difficulties; a man who can take any problem as it presents itself, and from his own knowledge "size up" the question and determine just how to attack it. In this way his judgment is developed. His added keenness of perception gives him a mental grasp and that self-reliance which, to my mind, cannot be given as well in any other way. This, so far as its educational value goes, is the important function of research, which should be a part of every curriculum of technical work. I do not believe at all myself in the system of training along narrow lines. Of course, what I say to you this morning is but my personal opinion, and I would like to have it discussed later.

[1] An address delivered at the last meeting of the Michigan Gas Association.

I believe that when the young man is going into the field of industry of any kind, such as gas engineering, which is one of our important ones, that he should get that broad training. In the early part of the course he should get the fundamental principles, and, later in the course, either in the senior or post graduate year, which is now supported by this Association, he should get his real finishing work. Such a man going into industrial work will be able to take hold of it with intelligence and force, and raise it above the level of a mere trade to the rank of a profession. These are the kind of men which the University should attempt to turn out. Such men can meet any and every emergency, and in a short time they will master all the practical details of the work.

It is very important, to my mind, that men should be trained not for the gas engineering profession only, but they should be so trained in general chemical engineering that they may successfully start in the iron or steel, cement, paint, sugar, starch, or any one of a large number of other industries, which could be enumerated. Most of our men do not know, when they are studying, into what line of work they will go. But they should be prepared to enter into almost any line of industrial work involving chemistry. It would be impossible for us, even if it were desirable, to made practical men in the ordinary sense of the word; that is, to attempt to give men in the University that practical experience which alone can be obtained at the works. Every young man when he leaves the University must begin at the bottom and learn the practical side. He must begin and learn simply the practical side of it, but if he has the training and the fundamental work, and above all, to my mind, if with those he has that ability to use his own brain and to thoroughly comprehend both the chemical and mechanical problems, then his difficulties will be comparatively small. It will not take him one-fifth of the time to learn the practical side of it that it would a young man who has not this training. Such a man as that will increase in value very much more rapidly than another. And it is with the hope of turning out such men as this, who have this power of increasing in their earning capacity, increasing in their value to the profession which they enter, that we give research work. And it is to enable us to turn out more of such men and to induce such men to go into the gas industry that this Association supports this fellowship.

The University cannot be considered, and I do not think that many in this Association would consider the University, in any way as an investment association. The University is not there for that purpose. There are, to my mind, two functions which the University should fulfill. First, the educational one. That, of course, is the primary duty of the University, to educate men. The second function, which perhaps is equally important, is to become a source of knowledge of new facts. Many of our small colleges and high schools, of course, fulfill to a certain extent the first of these requirements, the purely educational one along well established lines on well-known facts; but a great State University, and it is your University as well as that of other taxpayers, should be a source of information and of knowledge to all of the people of the State, as well as to the rest of the world. Research work that produces this information, requires, of course, support; it requires financial support. This State has been pretty liberal with the University and we have but little complaint to make, but still scientific research work is necessarily expensive, both in respect of money and in time, and the result of this research work must, of course, be of value to all those industries dependent upon the facts determined. No matter what line research may follow, whether it be in organic or inorganic chemistry, medicine, biology, or any other line you may choose, the industries that depend upon those facts should, I think, feel called upon to do what they can to encourage and support researches along those lines.

It is very gratifying to me to find this State Gas Association to have been so liberal in its support of our fellowship. Perhaps the most gratifying part to me is the spirit in which the great majority of the members of this Association have supported our fellowship. They have not asked us to return to them 2 dollars for every dollar invested. They have not asked anything of that kind. They have trusted us (I hope their trust is not misplaced) to do with it to the best of our ability and to utilize the money which they gave to us in developing young men who will increase and strengthen this Association, and at the same time bring to it, if possible, such facts and such new knowledge as may be of value to the gas industry.

In beginning a research, and we will say the research supported by this Association, we naturally select as a subject something which has promise at least of being of value to the Association and to the gas industry. We select our subject. We cannot promise that within a year, or 2 years, or 5 years, with any certainty, that facts will be brought out which will apply immediately and which can be converted at once into dollars and cents. That cannot be done on account of the way in which research work, to be properly carried on, must be undertaken. When research on any subject or any line of work is taken up, we must for the time being set aside all considerations of its direct application. We must not allow ourselves for the time being to think of the application, or whether results obtained are going to be convertible into cash at once. The moment a man does that, just that moment his judgment is warped and he cannot be conscientious enough to make or form an unbiased judgment. The work which must be done in the University (and this is a question for discussion, too), is simply to get at truths without any bias whatsoever; get at the facts; get at the absolute truths, no matter whether the facts developed are of benefit or not for the time being; but get at the facts. When the facts are once brought out, and we know that phenomena are as described, then is the time for the application of those facts to our various industries.

This is particularly important to my mind in the development of many of our American industries and scientific work in this country. As we all know, if there is any nation in the world which is quick to pick up and see the application of facts to the development of the money making industries, it is the American people. And it is this very brilliancy in those branches of scientific work, in which the results cannot be easily applied and converted into cash, that has brought about great progress in strictly scientific research. If we take such subjects, for instance, as botany and biology, and especially the former, we find that some of the very finest researches that have ever been done anywhere have been done in this country. Such superior results have been obtained because men have gone into those lines without the idea of applying their facts to practical ends, and consequently they have given all of their energies to the development of the facts themselves.

When you consider our other industries such as your own gas industry, or iron and steel (and perhaps I am as familiar with that as with any), cement making, or a large number of other manufacturing industries in this country, we find that the development of the manufacture has been brought to a higher degree of perfection in this country than in most others. This is notably true in regard to the steel industry. No other country in the world can produce as high a grade of steel for the same money and in as large amounts as can be done in this country. Why is it? Largely because some of our brightest and strongest men have entered the steel business. They have utilized the facts that have been brought out largely in England, Germany and France, but unfortunately only to a small extent in this country. Their keen perception has enabled them to apply these facts to material ends. They have learned from those researches why certain elements affect steel as they do; why it is that certain heat treatment of steel produces physical properties; why it is that phosphorus under certain conditions is reduced and enters steel and in others is oxidized and prevented from entering. A thorough knowledge of the materials handled, combined with natural American ingenuity and energy, has brought about the present development of our American industries. But it is only within the last few years that we find the knowledge upon which these industries really depend has been worked out in this country. It has been left to a great extent to men in other countries to show us the real reasons why we work as we do.

I think that this country should progress, not only in the line of applying the knowledge which other men in other countries have worked out, but it should furnish its share of knowledge to the manufacturing world. This knowledge may well be largely developed in universities, if this knowledge is to be universally distributed for general use. A great many of our manufacturing industries, and I have some in mind, employ from two to a dozen research chemists, or men doing strictly research work, practically just such work as we do at the University under this fellowship. They are doing this work with a view of developing the facts and of obtaining a true and unbiased knowledge. Then, after that knowledge is developed, it is applied to the various plants under the jurisdiction perhaps of one central company, and this knowledge is kept entirely to the companies themselves.

This Gas Association has taken a very desirable position, and one which reflects great credit upon it, in encouraging research in our University, research for the development of facts which we hope will in time be of assistance to the development of the gas industry. Incidentally we hope you will feel that you are getting in return some compensation in the men which we will furnish you for your work. We try to turn out men who will enter your profession, for gas engineering is now a profession, and who will help to raise the gas engineering profession in this State above that in any of our adjoining States, unless they follow the same lines. We hope that we can furnish you men whose services will compensate you for the amount which you invest in the University.

At the same time this Association will receive a great deal of deserved credit for the spirit in which it has encouraged this research. Whatever we may do at the University will, of course, be known, not only throughout this State but throughout the country and abroad. Any contributions to knowledge which may be worked out under the fellowship of the Michigan State Gas Association will in all of our publications be credited to the Association. In this way I hope the Association will feel repaid for its generous support.

The work in the University should not be on the application of the facts. If we can bring out for you knowledge which can be applied I have not the slightest doubt that there are plenty of men in this Association who will quickly grasp the significance of these facts and apply them to the development of your industry. It is the men in the industries, the men who are actively in a practical work, who can take these facts and develop them. It is the duty of the University to bring out this knowledge which can be utilized, and it is the duty of the men in the industries to take this knowledge and apply it. Men who have had the training in research, who have learned to appreciate the significance of underlying facts, will be very quick to see where this knowledge may be applied.

Take for instance our own research work, which we started under this Association. We started with a few ideas in mind. We first took up with Mr. Russell the relation between heating power of gas and its illumination in flat flames. We found as a matter of fact that there is little relation between the heating power of gas and the flat flame illumination. On the other hand, when we came to study incandescent mantles, we found entirely different conditions. By the work of Mr. Russell, and later on of Mr. Traver, we find that the illuminating value of the gas, or the candle power measured on mantles, is a function of the heating power. The higher the calorific power of the gas the greater will be the illuminating power of mantles, although that does not hold true of the flat flames. We find in addition that 80 to 90 per cent. of the air necessary for complete combustion of the gas should be mixed with the gas in the barrel of the burner before reaching the mantle. If we do not get this proper mixture then we do not get the maximum efficiency. Now, what does this mean? We hear of the construction of Welsbach burners. A great deal of work and an enormous amount of ingenuity have been expended on the construction of the burners. We find alterations are necessitated on account of the charge in chemical composition, or the amount of heating power of the gas, or the gas pressure. While the men at work upon the alterations in the mechanical construction many not realize it, they are unconsciously trying to obtain a maximum efficiency. And what does that mean? It simply means that those men are really trying to so construct their burners that they will take in 80 to 90 per cent. of air necessary for complete combustion through the barrel of the burner. Of course, this means a change in the form of the burner making the admission of the air dependent upon the pressure and composition of the gas. That was really what inventors were doing when they changed their burners in their efforts to obtain highest efficiency.

Another thing which was brought out by this research was shown in the later work. Temperature is only one of the two conditions determining the candle power of a mantle. There are two factors controlling candle power; the first, as I have said, the temperature; the second, the composition of the mantle itself. To control the first of these, namely, the temperature, what must we do? Two things suggest themselves at once. In the first place, a gas of high calorific power will naturally, if burned reasonably quick, raise the mantle to a higher temperature than one of lower calorific power. But there is another factor entering into the problem at this point, namely, the rate of combustion. We know that the more gas you can burn within a limited time over a certain area the higher is the temperature. In other words, the quicker your combustion the higher the temperature attained. By introducing gas at higher pressure, what do you do? You simply so construct your burner that from 80 to 90 per cent. of air is mixed with the gas and the rate of combustion is increased, which will result in intensifying the temperature of the flame with consequently higher illumination. This is the cause of the advantage of higher pressure in burners. So you see that we have knowledge and the facts which underlie these phenomena. I think there is plenty of ingenuity, also plenty of men of ability in this Association to apply this knowledge.

Then, again, comes this question, which we have just brought out as a second factor entering into the composition of the mantle—the effect of composition, the work performed by the cerium oxide. By our work so far this year, apparently we have disproved the theory at present held by the most prominent experimentalists in Europe; namely, that temperature alone is the factor determining the candle power of a given mantle. As was explained in our paper[1] yesterday, they maintain that the function of cerium oxide in these mantles is in some way to enable that mantle to attain a higher temperature than if the cerium were absent. I think we have completely proved that this is not the case. For we have taken the mantle containing 1 per cent. of cerium oxide, compared it in temperature and in luminosity with a pure thoria mantle, and found that a pure thoria mantle, although it may be even higher in temperature than the mantle containing 1 per cent. of cerium oxide, still emits very much less light. Therefore, temperature cannot be the one factor. Now, what is the function of the cerium?

In research work after the observation of a certain number of phenomena the investigator will naturally form a tentative hypothesis, and then so arrange the experiments, irrespective of any application of anything of the kind, as to test the truth of his hypothesis. He will simply ask himself certain questions—if my theory is right, then if I experiment along certain lines I ought to get certain results. The experiments along those lines should prove or disprove the applicability of the theory. So that a man in his research work must have his mind perfectly open to convictions, absolutely unbiased, taking phenomena and data just as they come and using his judgment the best he can. With this in mind we take as a tentative hypothesis that the function of the cerium oxide is not to raise the temperature but to alter the wave length, to convert the energy of the flame into the short light waves rather than into the longer heat waves, thus increasing luminosity without elevating the temperature. Much of the work that has been done upon the temperature of the mantle has been done by photometric methods, which measure the wave lengths and assume the shorter the wave lengths the higher the temperature.

This assumption is not necessarily tenable at all. There is no reason, to my mind, why certain dissolved oxides like cerium oxide should not possess the power of altering wave lengths and thus convert a much larger proportion of the energy into the short wave lengths perceptible as light. If that is so, if we find that cerium oxide performs this particular function, this leads at once to the consideration of the question whether the mixture that we have of thorium and cerium oxide is the most efficient mixture that we can obtain. If we find that certain oxides in solid solution have this property is it not entirely possible that other oxides in other proportions may possess this property to a greater degree? It opens up this line of thought and study. Undoubtedly this has suggested itself to manufacturers of mantles, and probably a good deal of work has been done along this line; but if this work has been done it has been kept very carefully to the manufacturers themselves and is not a matter of general knowledge.

Another line of work on this same general subject, which was suggested to me by one of your members, and to which we have already devoted some thought and experiment, is the question of the durability of the mantle; the cause of its deterioration. This is a very important, practical as well as theoretical, question. If one, or two, or three, or five years' work would bring out with definiteness and certainty the causes of deterioration, and there could be suggested from those causes a remedy for deterioration, you certainly would be well repaid for the investment for that number of years. A few well established facts will often be of enormous value to the industry. And there is no question, as I said before, that if we can bring out to you facts which are determined with absolutely unbiased judgment, and are well proven, there is little doubt but that the members of this Association will soon apply them and reap the benefits from their application. It is not the duty of the University to apply the knowledge which it has brought out to the development of a particular industry.

We have had several cases where manufacturers would have been very glad to support a man, provided we would put that man on a particular subject, work it out on the commercial basis for them and give the results to them, but to them only. This is not the work of the University; and I am glad that this Association has not shown that spirit, but that it is working in harmony with the University, supporting research work, for the facts that will be brought out.

The University will try to bring out for the Association in return for their support, knowledge and facts which the members of this Association can utilize, and will try and return to you also a class of men who I hope will gradually fill up the ranks of this Association and raise it above the level of that of any other Association in the States. If we can do this, if we can return to you, gentlemen, men who will enter your ranks, who will be efficient, strong, vigorous men, who will raise your profession upwards, then I think you ought to feel that we have returned something at least to compensate you for your support. These are my ideas of the way research should be carried on, and the relation which should exist between our manufacturing industries and the University.

1. See JOURNAL, March 24, 1902, p. 413.

The Flat Rate Nuisance.

[A paper read by MR. THOS. D. MILLER, of Dallas, Tex., at the San Antonio Meeting of the Southwestern Gas, Electric and Street Railway Association.]

A flat rate is a rate of so much for all you want. As applied to the lighting business it calls to mind the old adage, "Evil practices corrupt good morals;" or, more appropriate to the subject, "Evil practices corrupt good business methods."

My first experience with a flat rate was when, as a boy, on the last day of the county fair, late in the afternoon, such a rate was given by the lemonade man; that is, all the lemonade you could drink for a nickel. This would seem to have been a good business policy, because he was overstocked on an article which would cease to have a commercial value after the crowd was gone. How different it is in the case of the electric light. I have heard it said it was economical to take lights on at a low rate in order to give the machine a load up to an economical basis. This might be warranted as a temporary expedient; but its wisdom as a policy is questionable.

When the electric light companies first introduced the flat rate there were no available means of keeping track of the number of hours consumed on the lamp with an automatic device. Some meters were invented, but while the principle on which these meters worked was apparently satisfactory, in a mechanical way, it was in reality otherwise; the first cost being so great seemed to prohibit their general introduction. The result was that, in the rapid progress of the electric light business, this method of arriving at a measure of the commodity which everybody seemed to demand being impracticable, the flat rate was established, and if one wanted a lamp to burn until 10 o'clock he was put on a 10 o'clock rate and circuit, and when that hour arrived the service was discontinued from the central station. If one wanted to burn light until 12 o'clock he was put on the 12 o'clock rate and circuit, and his "light went out" at 12 o'clock. If he wanted an all-night light he was put on the all-night rate and circuit, and at daylight the service was discontinued at the central station; in fact, the entire plant was shut down at daylight. This became more or less unsatisfactory, as parties using electric lights were often discommoded through having their lights cut off at the stated times, when their business was not quite ready for the lighting suspension.

Many of the electric light companies were forced to increase the time in which current could be had, from a late hour in the evening to all day and all night, so that the people using electric lights on a flat rate had been unconsciously accustoming themselves to taking more light than was necessary and more than they were paying for, and no effort had been made to economize in its use, as none was necessary from their view point, until now the present generation can hardly remember the time that electric light did not cost so much per month.

When the incandescent electric light was introduced there was still no practicable electric meter for measuring the consumption, and the electric light vendors, being in the habit of billing light at so much per lamp per month, continued in this way on their incandescent lamps.

When the electric lights were first introduced the price of gas all over the country was, as compared with its present price, two, three or four times as high as it is now, consequently gas bills were very much higher than they would be to-day, for the same amount of light used in the same way, so that when the electric light man first tried making flat rates he could make one a little below the average cost of gas and get a good price; this he undoubtedly did and made money at it. When the gas man found a new Richmond in the field, "he began to economize in the cost of manufacture and distribution, and to improve the quality of his light." The American public has a memory, and when it once got an idea that the price of gas was high, it retained this impression a long time, and even after the price of gas and improvements in the method of using it had brought gas light to a point where it was cheaper than electric light, the electric light man was still able to get a better price for his light than the gas man, and probably always will; if he cannot he is in "hard lines."

The consumption of the electric light has grown so rapidly, and the competition, not with gas alone, but with additional electric light companies, has been so great that the price on the flat rate basis has gradually been reduced to such an extent that in many cases electric light companies find, after several years, that, notwithstanding the fact they have been having large receipts, their expenditures for repairs and renewals and operation cost are exceeding their incomes.

A flat rate is unfair to either consumer or vendor, else there is no reason for a meter not being used. If the consumer is not using as much light as he is paying for, it is obviously unfair to the consumer, even though he be satisfied. If, on the other hand, the consumer uses more light than he pays for, it is equally obvious that the vendor is suffering, though he may be unaware of it.

There is not a plant using the flat rate basis of charge that has not some consumers who use more current than they are paying for, and if such plant is making money some of its consumers are paying enough more for their current to compensate for the loss on the other consumers.

There are still some advocates, among the electric light men, for a flat rate; but there are more among the consumers, who find they have been obtaining their light at less than the cost of producing it; and nearly all such consumers look upon the flat rate as an eminently proper thing. There are reasons why a consumer of electric current should receive some concession on the total current used, where he is a consumer of current for an extended number of hours outside of evening lighting hours; but each consumer can be cared for by having a lower rate on a consumption basis, and no tenable reason can be assigned for such consumer getting his current at less than the total cost per unit of operating and maintainance expense.

It would seem that at this date there is little room for argument on a business basis in favor of a flat rate. A merchant would regard as ridiculous a proposition that he furnish you with all the clothes, all the shoes, or all the groceries for your family for so much per month, and yet those same merchants expect to get their electric light at a flat rate, and they have been known to appeal to the authorities in an effort to perpetuate it. This is not because they are naturally disposed to be unfair or unreasonable, but it is the result of an education for which the electric light men are responsible and for which the electric light men have paid.

The blustering boast of one of two competing concerns, as to how cheaply current can be made, is accepted by the public as a fact, and the popular belief to-day is that electricity can produce more light for the same cost than can be done by any other artificial means. Those of you who are posted know to the contrary, and if others hold contrary opinions, it behooves them "to post up and get right."

I believe it is a fact that any electric light plant doing an exclusive flat rate business could furnish current to from 25 per cent. to 75 per cent. more lamps at the same cost for operating expenses than it is now doing, or have the gross receipts proportionally increased if it could but collect a fair price for the service rendered to each customer, and no more than a fair price from anyone.

The solution of the situation that is presented to-day is the introduction of a reliable watt meter. Many electric light companies are doing this as rapidly as conditions will permit, and are gradually thereby going on to a paying basis.

Fuel Gas for Domestic Use and Small Trade Purposes.—No. I.

[By THOMAS FLETCHER, F.C.S., in *Journal of Gas Lighting.*]

In some rough preliminary experiments with this, one point which appears to have been entirely overlooked as regards effective duty in practice, is the well-known fact that, in the absence of a regenerator, the useful duty is in direct proportion to the difference between the temperature of the flame and that of the object heated. In boiling water, the duty comes out very near to that stated by the advocates of fuel gas. The same work done by 10 cubic feet of coal gas can be equally well done by about 40 cubic feet of Dowson-gas, with the same burner; the only difference being in the bore of the gas jet. A properly proportioned atmospheric burner for coal gas, when the gas outlet is enlarged to the correct size, makes a very satisfactory burner with the lower quality, for many purposes. Owing to the lower temperature of the fuel gas flame, the proportionate duty for higher temperatures does not hold good; not only for the reason stated, but also that a great loss is incurred by the higher temperature to which the much larger percentage of inert gases have to be heated, and then thrown away. A long series of experiments, which I hope to be able to complete, will be necessary to determine the basis on which calculations of cost can be made. From the result of a rough preliminary test, it would appear that to heat an iron plate to 600° F., the work which can be done with 3¼ cubic feet of 18-candle gas, requires about 35 cubic feet of Dowson gas made from anthracite coal, under the same conditions. How this will work out when both gases are used with an air blast remains to be seen; but from theory, it would appear that the proportions will remain the same. This test is open to suspicion; the result may prove to be too low. The apparatus was new; and it is possible that the water in the holder tank

was still absorbing carbon monoxide, thus reducing the heating power. But further experiments with carefully and freshly made gas, after the holder had been in work some time, show the duty available to be extremely low. After several trials a blowpipe was selected and adjusted to give the highest temperature with Dowson gas. With an air pressure of 1¼ pounds per square inch, and a gas pressure of 4 inches on the holder, the consumption was at the rate of 180 cubic feet per hour; and this flame melted a thin rod of cast iron, backed with firebrick, in two minutes—gas consumption, 6 cubic feet. With coal gas, and a blowpipe equally well adjusted, with a gas consumption of 60 cubic feet per hour, the same blower being used, the same rod was melted in 50 seconds—gas consumption, ⅝ cubic foot. The Dowson gas thus required 7 times the quantity, and more than twice the time, as compared with coal gas. This, in practice, would show no economy with the poor gas, though the latter was assisted by the high pressure at which it was delivered. For blowpipe work, the air pressure is practically limited; a higher pressure blows the flux and solder away, and disturbs light work. The test of plate heating is only given to show the ease with which errors can be made, the great caution necessary to obtain reliable results, and to call attention to a very simple test by which any user can closely estimate the heating power of any gas. This will be mentioned in due course.

In heating inclosed spaces, such as cooking ovens, japanning, core drying stoves, and similar work, the gas required can only be determined by experiments. These experiments will be made with ovens, and with metal melting furnaces, etc., so that actual working data and costs can be determined. It is rather unfortunate that these were not made years ago, as, from the one recorded above, it would appear that the so-called "cheap" fuel gas will, for many purposes, prove to be very costly in practice; and the feared competitor to coal gas will only prove a bogey and a shadow. Personally, I am much disappointed; as, for larger work than is usually considered to be within the scope of the apparently expensive coal gas, I hoped to be able to fill a great want. It must be clearly understood that all forms of regenerator are excluded. These are bulky and expensive, and are not at present applicable in practice to the requirements of users whose work lies between the range of coal gas and the large installations where bulk and special attention are of secondary importance. One difficulty in testing the comparative costs of fuel gas and coal gas in practice is, that where the former is used there has been no apparatus for testing the actual cost of any one operation; and if it is used on a very large scale, the cost of what is considered small work is not taken into consideration. If the fuel gas is ever distributed for general public use, for domestic and small trade purposes, it appears likely that coal gas, notwithstanding its high initial price, will prove the cheaper fuel in practice.

With regard to the purposes for which the higher duty can be obtained—boiling water, etc.—the experiments were made under precisely the same conditions with the different gases, in a small but well ventilated room; the outlets being at the highest point in the roof. As with coal gas, the vessel containing the water was in contact with the top of the flame; and this means that some of the gas escapes unconsumed—more than with coal gas, as it is much more easily extinguished by contact with any cold substance. There is no doubt whatever that the effect of this unburnt gas is very unpleasant; and the question arises to what extent the unpleasant, if not unhealthy, effect takes place when coal gas is mixed with water gas. There is no smell when Dowson gas is partially burnt; but there is a very unpleasant effect if used in a room. It can be prevented, of course, by lifting the vessel out of the flame; but this means a much smaller duty for the same consumption, and it would appear that the figures given, and accepted, from theory, of 4 to 5 cubic feet of fuel gas being equal to 1 cubic foot of coal gas, will have to be very seriously revised, and that for some purposes the consumption of the poor gas, in actual work, will be nearer 10 than 4 times that of coal gas. The special plant which has been executed has been designed to test this matter under all conditions; and the results will be of the greatest importance.

It must be clearly understood that, in these preliminary notes, I have departed from my usual custom of never publishing any figures or results which I am not prepared to prove to be absolutely correct. The remarks are based on rough experiments, which may or may not be exact; but they are, at the present time, of serious importance, and the suggestions may be useful to those who are experimenting, or intending to experiment, in the same direction. We have for many years been making special apparatus to be used with fuel gas, but have never attempted to guarantee the actual duty and cost in practice. Up to the present, it would appear that coal gas is likely to hold its own position at the top, both for heating and lighting, in competition with either fuel gas or electricity. It may be also of interest to mention that we have made for some time past small electric furnaces for enamelling; but the cost of working these is quite prohibitive when cost is of any importance.

The figures given refer to Dowson gas; but as this is, on the average, rather better than Mond gas or any of the producer gases, it may safely be taken as a standard of reference. Dowson gas, properly made, burns well with a clear blue flame, which will heat thin iron wire to dull redness. Some of the fuel gases will not burn at all unless previously heated; and I note in one patent for using the Mond gas for incandescent fires, an arrangement is claimed for heating the gas before burning, by placing a coil of the supply pipe where it is surrounded by waste heat. This may be an improvement; but it means complication and expense.

There is another question which will have to be decided some time; and the sooner the better for all concerned. When water gas is carburetted and mixed with coal gas for general distribution, does this mixture become extinguished at a lower temperature than coal gas alone; and, if so, what proportion of carbon monoxide escapes unburnt when a vessel of cold water is placed in contact with the flame, as it is at present with coal gas? Judging from theory only, it would appear that the results, as regards the atmosphere of the room, would be practically the same as with coal gas alone; but the matter should be proved by a careful and reliable analysis of the products of combustion—theory only should not be relied on. I should have been pleased to take this matter up but for two objections. Our apparatus is designed to produce Dowson gas only, which is essentially different to water gas in its composition and behavior; and the experiments must be carried out by someone who is an authority on the subject, and who has no interest in, or connection with, the commercial side of the question—there must be no shadow of suspicion of any bias or commercial interest in the results.

Where a diffused heat is required, which is very rarely the case, no doubt any of the producer gases will give a fair duty as compared with coal gas; but for small work and small industries the greater part of the work to be done is local—confined to a small space. With producer gases, more than two-thirds of these, and of the air supply required, are inert—they simply enlarge the flame and lower its temperature, giving a diffused heat of the same total power, less the loss entailed by heating the inert gases, and also by spreading the heat where it is not wanted. The reverse of this result may be seen in the very high duty which can be obtained by burning coal gas or hydrogen with oxygen. The total heat evolved is the same; but the duty obtained in practice, where an intense rather than a diffused heat is required, is enormous. The difference may be compared to the results obtained by dry charcoal in a furnace, and this same fuel saturated with water. The theoretical duty is the same in both cases; but the useful work done is very different, unless the required temperature does not exceed the boiling point of water. Where this is the case, the steam will give up a portion of the duty which would be otherwise wasted.

Although fuel gas made from anthracite coal appears to be better than the average in quality, it is evident that it varies considerably, and probably will do so with most generators. No experiments will be of any value unless checked by some standard—such as boiling a specified quantity of water in a vessel of standard shape and size. This is an easy and sufficiently exact method of comparing different samples of gas, and must be repeated as a check to every experiment. It is clear that the useful limit of temperature available is comparatively very low. I have before me a report of an intending user of fuel gas for metal melting, in which it is plainly stated that after a considerable number of trials, with an unlimited gas supply and powerful air compressors, it was found impossible to obtain, in a crucible, a temperature higher than would melt ordinary brass. As usual, no figures were available; but it was mentioned that the consumption of gas was "enormous." In the same furnace, which is made of a special non-conducting material, an ordinary atmospheric flame with coal gas, without air under pressure, would do this work easily. There are thousands of comparatively small metal workers who would be only too glad to do their melting with a cheap fuel gas if it were possible. Judging from the appearance and temperature of the flame of the gas from anthracite, with the Dowson producer, it would appear that results may be obtained with this which are impossible with gases made by any other fuel or generator; and if this proves to be the case in practice, as 1,000 cubic feet of Dowson gas can be made from 13 pounds of anthracite, or 8,000 cubic feet from 1 cwt., it is possible that the outlook for the Dowson gas for high temperature work may be better than appears likely for any of the other fuel gases.

Some tables I have before me give the combustible gases as:

Siemens producer	25 per cent.
Mond	38 "
Dowson	44 "

But it must not for a moment be supposed that these are the actual comparative duties obtainable, though this may be the case under some conditions. For instance, Dowson gas contains 56 per cent. of inert gases, and Siemens gas 72 per cent.; and a larger proportion of heat is wasted in heating up the inert portion of the latter, only to be thrown away. For this reason, the vanishing point of useful duty is much lower; and above a certain point (yet to be determined) an unlimited supply of gas, used in a battery of blowpipes with an unlimited air pressure, would actually cool a furnace, if the temperature is above a certain point. It is therefore clear that, if a fuel gas is to be supplied for general purposes—domestic and small manufactures—it will be quite as necessary to create a legal standard, as with coal gas; and unless this is done, it will be easy to increase the working cost to the user to double or treble what it should be. This analysis and guarantee means examiners, testing stations, and incidental expenses, which would make a "cheap" fuel gas a more doubtful matter than it is at present. One maker of producer gas plant strongly recommends gas—made, of course, with *his* producer—for firing steam boilers. I should very much like to see a reliable test of this, as compared with ordinary slack or burgy, for working costs (say) for 1 or 2 months' running. I believe I am correct in saying that Mr. J. Emerson Dowson has stated in the plainest possible language that steam boilers cannot be fired economically with producer gas.

Central Station Heating.

[From a paper read by MR. D. F. MCGEE, Red Oak, Ia., before the Iowa State Electric Light Association.]

If we are to take up the subject of central station heating from a mechanical and financial standpoint, it will be necessary to weigh very carefully the many points which cause the plant to be a financial success or a failure.

Spreading out promiscuously all over town must be avoided, and only just sufficient mains should be installed to use up all the available exhaust steam. The proposition should be to utilize only the exhaust steam to the best advantage. The claim of certain promoters of heating systems that there is money in live steam heating, and that the electric light and power furnished need only be considered as a by-product, is untrue, and has resulted in the installation of heating plants which cannot be run on a paying basis.

My experience with the various steam, hot air and hot water systems has convinced me that nothing meets the universal requirements for a central plant as well as hot water heat. In fact, it is the only heating system in which regulation of temperature in the various buildings is absolutely under the control of the attendant at the central plant, without a complicated system of thermostats, that increase the first cost of installation, and are always getting out of order and are consequently a continuous source of expense.

In our plant we have posted near the thermometer in the main supply pipe a carefully tabulated schedule by which the engineer can tell at a glance how hot the water must be to warm the building to 70° at any given outside temperature. As a result our customers seldom touch a radiator valve during the entire season.

The fact that the temperature of the heating surface in the entire system can be controlled is of particular advantage in moderate weather, for by controlling the temperature with a hot water system a given amount of heat can be spread out thinner and do more work than the same amount of heat will do with a steam system. The customers need not touch an air valve, consequently that disagreeable odor of cylinder oil, so much in evidence where exhaust steam is used direct for heating, is entirely eliminated, as well as all cracking and snapping of pipes, so familiar to us all, where steam is used for heating buildings.

To make a plant successful every corner must be guarded, and frequently small economies determine whether the plant is profitable. To illustrate: In operating an exhaust steam heating plant, there occurs loss of power and useful work due to back pressure. It often amounts to 25 per cent. of the power developed, and, in some cases, to as much as 50 per cent. There is also an important loss due to throwing away the water of condensation, a common practice in exhaust steam heating. Aside from the value of the heat so wasted, the loss of so much pure distilled water, so good for use in the boilers, is a considerable item.

In operating a hot water system, some power must be used to circulate the water.

I know of no better way of taking up this subject intelligently than to give you a brief description of our plant, with a statement of results which we have obtained.

Our pipe system consists of a closed loop or circuit of 5-inch pipe about ¾ mile long, with three 3-inch shunts, each about 1,000 feet, extending off the main line. In this circuit, and part of it is a centrifugal or fan type of pump, an exhaust steam heater and a live steam or auxiliary heater. The exhaust steam from our engines first passes through an open feed-water heater and grease extractor, which heats feed-water for our boilers and also removes the cylinder oil from the exhaust steam. It then passes through the exhaust heater for the heating system, where it gives up its heat to the circulating water, the surplus, if any, escaping to the atmosphere.

As this exhaust heater is elevated above the water line in the open feed water heater, the condensation from the exhaust steam flows to the feed water heater by gravity, to be pumped to boilers as feed water. This insures us distilled water for our boilers at a temperature of at least 205°, and enables us to use our water over and over again, which makes a very material reduction in our water bill as compared with those we pay in the summer months. There is an opening direct to the atmosphere from the exhaust heater at all times, so it is impossible to put any back pressure on our engines, and indicator cards taken from engines show that we can condense every particle of our exhaust steam without using an ounce of back pressure.

The live steam heater is elevated some distance above the boilers and is similar to the exhaust heaters, only much smaller. Here also steam passes through tubes surrounded by the circulating water of the system. When live steam is required for heating, it is taken from the main steam pipe direct to this heater. The condensation from the live steam returns to the boilers by gravity at the temperature corresponding to the pressure. This means returning the water to the boiler at a temperature of over 300°, instead of allowing it to flow to the sewer, which is done in all steam plants and other hot water systems, where it must be replaced by water at an average temperature of 40°.

Any person who has ever tried to run a large heating plant where extra boilers are used to heat the water knows that it is an absolute impossibility to regulate the temperature of the water, as the grate surface necessary to heat sufficient water to warm the buildings at zero weather would be too large when the weather is 30° or 40° above zero, consequently the water is either too hot or too cold, and by attempting to regulate the fire you must necessarily waste a great deal of coal. We are able to control the temperature of the circulating water to a degree, this being done by merely opening and closing a valve. This means a very large saving when it is necessary for us to use live steam, which is on Sundays, holidays, and when the weather is about 10° above zero during the daytime, as we find that at about this temperature our exhaust steam is not sufficient to heat the water warm enough.

Our circulating pump is of the centrifugal type, and requires only 12-horse power to maintain a difference of 20 pounds between the supply and return, that being our circulating pressure.

Our system is a close one and we do not have the static head of water to pump against. The pump gets the benefit of the pressure, due to the height of the highest radiator, on the suction side of the pipe, which any system using a so-called storage tank is compelled to lose, as the storage tank leaves an open place in the return circuit. Such a system calls for a steam-driven duplex pump, which type of pump requires at least 150 pounds of steam per horse power hour, while our pumps are driven from a Corliss engine with an economy of about 28 pounds of steam per horse power hour. Now, even if our system did require the same amount of power to circulate the water that other systems do, the difference in the type of pump employed would show that we only use one-sixth as much steam to do our pumping; but further than this, we only pump against one-third as much pressure. Consequently we use in doing our pumping about one-eighteenth as much steam as the other systems.

Our house connections are merely shunts taken off the mains. The size of each house shunt depends upon the number of feet of radiation required in the building to be warmed.

Our plant was started up in October, 1899, and the first season we had about 14,000 square feet of radiation in service. This gave us a loss of 8° from the time the water left the plant until it returned, and when the thermometer was 10° below zero. This year we have increased our load to 29,000 square feet, and the difference during our coldest weather is 15°. I have learned from experience that it is a great advantage to make the house connections a little large, as we found last winter that we could shut down our pump for 5 or 6 hours at a time without our custom-

ers being aware of it, as the water, having acquired its momentum while the pump was running, continued to circulate after the pump was shut down. passing through the exhaust heater to be reheated and then acquiring motion from the change in temperature. Just so long as the water remained warm in the mains it continued to circulate through the buildings that were equipped with 1¼-inch and larger sized street connections. This year, for buildings requiring 1,200 square feet of radiating surface and less, we made the street connections 1¼-inch. For buildings requiring a larger amount of radiation, 2-inch connections.

We have all learned that to make an electric plant pay we must avoid the slipshod methods of construction which were considered good enough a few years ago. It was then thought that any kind of an electric plant was a gold mine, and we will do well to profit by the sad experience of a great number of lighting plants which were thrown together with this expectation.

To place a heating plant on a paying basis, it is necessary to watch and take advantage of every point. Do not think that you can dig a hole in the ground, lay in it several miles of pipe, throw a few fence boards around it, run a block here and a block there for every building, and expect to pay 100 per cent. on the investment, simply because some smooth fellow tells you that a heating plant is a gold mine.

In the first place, all underground work must be done in the best possible manner, bearing in mind that the mains cannot be covered too thoroughly with a non-conducting material. All pipes should be thoroughly tested and leaks repaired while they are yet uncovered, for every drop of water, in fact every heat unit, represents money invested, and should be guarded accordingly. It pays to cover all cellar piping, such as mains and branches, with a non-conducting material at your own expense. I find that ½-inch asbestos paper, which comes in rolls of about 100 pounds, answers this purpose very well. We saw the roll up into blocks about 6 inches in length. This gives us long strips of paper 6 inches wide, which should be wound spirally around the pipe, first in one direction and next the reverse, until there are several thicknesses around the pipe. This is much cheaper and very nearly as effectual as sectional covering.

As I receive very many inquiries about our system of charging for service, a few words on that point may be of interest. We charge a uniform price of 15 cents per square foot for all radiating surface in actual use, making no distinction between large and small customers as to price. But we make this arrangement, which seems to meet the requirements: When our large customers, such as office buildings, have rooms which are not rented, we disconnect and draw the water out of radiators in these rooms. We take this precaution to avoid any danger of the water freezing in the radiators. We have in actual service this winter 28,000 square feet of radiation, which brings in an income of $4,320. Coal costs us $1.69 per ton laid down in fire room. The amount of coal chargeable to heating service for each month, including Sundays, when we do not run our engines, is as follows:

October	8 tons.
November	16 "
December	40 "
January	60 "

Judging from this we expect to burn about 300 tons of coal for heating purposes during the year, which will cost us about $500. This will leave a net income of about $3,800. While this has been an exceptionally mild winter, still a lower temperature would not increase our coal consumption very much, as Sundays are practically the only days that we find it necessary to use very much live steam. So far we have a very satisfactory plant, yielding a good income. [Cost of plant under $10,000.]

Now the question of extending our system comes up. Our customers who have the heat in their business houses want it in their homes, and we could double the amount of radiation in service by extending our mains, and our station apparatus was planned for this. Yet we have decided not to do so, for when we take into consideration the interest on the additional investment for street mains, and the fact that we would then be compelled to burn coal, make steam to heat our water, and probably require extra boilers, we fail to see where there is any money in the extra investment and expense. Now we find that to make the investment very profitable it is important to have a day load for the engines. This, perhaps, can be done to the best advantage by furnishing electric current to your customers for light and power at a rate which will make it an object for them to use it and still permit you to sell it at a profit. This is a point that is apt to be overlooked by many central station men.

The promoters of heating systems tell us that we can sell our electric current very low, because we will be deriving an income from the sale of our exhaust steam for heating purposes; and then, in the next breath, they tell us that we can make a low rate for heating because we are utilizing our exhaust steam as a by-product.

A few moments' reflection will convince any man that it is impossible to cut on both ends of this proposition and still come out ahead; and it is not necessary to do so if it is undertaken in the proper manner.

Our local conditions are similar to nine-tenths of the lighting plants in this State, and I find that it is not very difficult to work up a very fair day load, even in a small town which has blacksmith, machine shops, laundry, printing offices, dentists, grocers, butchers, restaurants, livery stables and numerous others who could use small power to advantage. Very many towns have one or two mills of considerable size, which can be secured as customers. City pumping, in towns where there is a standpipe or reservoir, is very attractive, for this work can be usually done when the load is smallest, which is the time you may need the most exhaust steam for your heating purposes. In our case several industries located in town for the very reason that electric power was available at all hours at a reasonable rate.

When soliciting prospective customers it is just as well not to lay too much stress on cheapness, but rather to enlarge upon the fact that you will be able to furnish them much better and more convenient service than they can secure in any other way, as a motor can be located in the most convenient place, and will not be a source of annoyance by causing dirt, heat or noise, and the customer only pays for the actual power used.

It is also advisable to make some arrangement with a responsible company to handle their motors. You are then in a position to go to your customer and quote him a price for the motor installed complete. You are very much handicapped unless you do this, for you may tell your customer that you will furnish him with power at a rate which may be perfectly satisfactory to him. He will write to different parties for prices on motors, and then his troubles will begin, and it is ten to one that he will become disgusted and drop everything.

By making arrangements with some manufacturer you can install the motor for a sum that will cover the cost of motor and necessary labor and still give your customer a lower price than any respectable manufacturer will quote them, and furthermore, you will have the advantage of standardizing your motors, which permits you to change them in case of accidents, and your repair men soon become familiar with the construction of the machines, which you will find prevents many accidents and facilitates repairs.

During the past year we have installed 34 motors, ranging from ¼ to 5-horse power, which, with one 85-horse power driving a mill 24 hours per day, and one 45-horse power motor doing city pumping, gives us an average day load of 150-horse power.

Michigan Taxation Plans.

[Address Delivered by the Hon. A. F. Freeman, Chairman Michigan State Tax Commission, at the Last Meeting of the Michigan Gas Association.]

Mr. President and Gentlemen of the Association: In behalf of the Tax Commission I desire to express its appreciation to this Association for recognizing that the Tax Commission of Michigan was of sufficient importance that it should be a feature of your gathering. Permit me also, gentlemen, to extend my personal gratitude to your worthy President for the kind remarks that he made here, and as well for those expressed in his letters to me. I want to say to you at the outset that I did not come here with any prepared speech, and whatever I do say will be altogether of an extemporaneous nature. I do not mention this as an excuse in any way, because I had notice of this meeting something like 2 or 3 weeks ago, and possibly should have prepared a paper for the occasion. I thought if I did prepare such a paper that it might be along lines that would be of no especial benefit to you, nor would it do the Commission any particular good. I have, therefore, concluded to speak of taxation in general along the lines of your President's suggestions, thinking it might provoke thought, so that some questions would be asked by the gentlemen present, and in this way obtain the best possible benefit to you and to the Commission I represent.

The subject of taxation is ordinarily a dry and uninteresting one, but in Michigan it has become so intensely practical that great interest has been awakened. There is not much music in the subject, nor is there much poetry to it, though I believe one poet did indulge a little when he said:

"Who'er expects a faultless tax to see
Hopes what ne'er was, is not and ne'er shall be."

But we are confronted to-day with a practical question. Let us no longer indulge in theoretical considerations. At least I do not purpose doing so here, because as an officer of the law we are to enforce the law as we find it. The theory of taxation has been settled in this State so far as the State law is concerned. Now that theory is the well known one that we shall pay taxes according to our ability to pay, that ability being measured by the worth of the property. In other words, it is the general property tax, so-called, which has two main features, and two only that are really important. The rest are details to carry same to effect, and that is that the property of this State subject to taxation and not expressly exempted, shall appear upon the assessment rolls. That is the first necessary feature. The next, that it shall appear upon the roll by a uniform standard of value—all valued alike. The statute, following the constitution, has said that this shall be the "cash value," the "*true* cash value" (in some places it is called) of the property. Now you have the theory of taxation in this State. It is, as I say, first, that all the property shall be listed and shall all appear, except that which is exempt, upon the rolls, and that it shall be valued at its "true cash value." That is the theory that is recorded and known in the books, and that theory is bound to bring about equality in taxation; it cannot help it. There would be no use whatever in this State of a Tax Commission if the assessing officers, who have this primary work to do, would place the properties on the rolls and place them there at true cash value; but we know that conditions were such in this State that the assessing officers did not do their duty in this respect. That assessments had run riot (so to speak) until there was absolutely no uniformity. We know that assessing officers, for one reason or another, did not assess the properties right.

They had everything at stake, you might say, to assess them wrong. They had their friends to assist, they had their party to assist, and they had themselves to assist, so that they might continue in office. And the good intending official, among these 1,700 or 1,800 assessing officers of the State, if he did intend to assess the properties right, would not dare do it for the very reason that if he did his constituency would stand more of the burdens than the others who were not paying their just proportion of the tax, because of the wrong assessments. That is the condition in which the Tax Commission, when it came into office, found the property throughout the State upon the rolls. No uniformity whatever. No laws, and especially tax laws, will work automatically. This is largely due to the fact that people are naturally selfish upon this question. If a man can get his assessment at a less figure than it should be, on the doctrine that money saved is money earned, why that man has made some money. And, therefore, we are all (and I am not an exception to the rule) naturally selfish upon this question; and I want to say to you in this connection that for some reason or other a condition, that I cannot exactly explain, exists—that some of the best citizens in this State, law-abiding in every particular, except along the line of assessment of their properties, try to escape from the burdens of the government by having their properties assessed as low as possible. That is a condition existing in this State. Either their just and fair conception of right and wrong is not expressed upon the assessment rolls, or else it is they can argue to themselves in some way it is right to do this. Therefore, you see the necessity of a Tax Commission. The necessity to have some body to control these assessing officers, and make them place the properties upon the rolls and in the right way, is apparent.

Now, we come down to the subject at hand; and in speaking of your interests, gentlemen, I wish to impress upon you that I do not come here to pass out any bouquets, because the Tax Commission never expects and rarely gets any. Neither have I come here with a club in my hand to stifle or destroy your interests in any sense; but wherever I have anything to say about this problem I do insist that we must hew to the line and see that all the properties in this State shall go on to the rolls, and that they be placed there by one uniform standard of value. So let us look at it in that practical way. The theory of it is settled. And permit me to say in passing that if we had any other theory, the human mind is so constituted that there would be just the same tendency throughout the State to dodge the taxes and escape the burdens as there is under the present system, and it would reach the same result. The law does not settle these questions. The theories do not settle them. The law and theory must be carried out. The theory which we have at the present time expressed in law, however, is the best theory in my judgment that ever was brought out. But it has been said that you cannot carry this theory to practical results. I answer you by saying if that is true it is because of the condition of the people themselves and the sentiment they create. If this law cannot be carried out it is because they desire immunity from taxation; and if this theory cannot be carried out, then no other one can be. That is the thought I want to bring home to you, gentlemen. It is the practical idea that we are dealing with the law as we find it, and if this wise law is carried into effect it will bring wise results. I claim it is the best ideal, to repeat, that has yet been thought out. Then how are we going to carry it out? It is by some supervisory control over these assessing officers; because, as I say to you, and emphasize it, if the assessing officers do their duty there would be no use of this supervisory control. This law of assessment taxation, nor any other law, will ever be obeyed implicitly and absolutely.

There is plenty of sentiment against larceny in this State, and there is plenty of sentiment against murder in this State, but larceny and murder seem to occur just the same. These are violations of law, and there will be violations of the assessment and taxation laws, no matter what theory we may proceed under. Then it comes to you, gentlemen, in a practical way, you being a body representing a vast industry in this State, to come to the rolls the same as everybody else should. And I want to assure you further that the Commission is not in any sense moved with the spirit of discrimination, nor has it a knife out for big corporations any more than it has for all properties. We know no distinctions. True, work may be put in where property centers, in the sense of "The greatest good to the greatest number," for the purposes of educating people and bringing out the thought that all property must appear. That is to say, we are more apt to think of the escapement of the large property interests than we are of a very small holding, but there is no distinction, and there should be none among our people, in the enforcement of any law. It may be said that the Tax Commission knows but little about gas companies, and in a sense we do know but little of them. So it may be said that it knows but little of farms, of mines, of the lumbering industries, and the banking interests, and the thousand-and-one enterprises that are engaging the attention of our people. But we do know this, gentlemen, that the assessing officers in the immediate localities do know something about these values, and that if we can secure their good judgment, we will have secured all that the law ever intended. Perhaps I know but little about gas (that is, the kind of gas you gentlemen indulge in), but I do know that you are here to-day representing vast holdings in this State. I do know that as you go to your respective homes and in your places you are the representatives of a considerable value of property in your localities. We know that you lay your mains and your gas pipes throughout the cities, and a large business is done upon a large capitalization. You may say that the Commission knows but little of the values of these properties. We know this, and we can argue the fact that as you have capitalization, earning powers, franchise rights and privileges to do business, it must be a business of considerable importance. There are many ways to measure the value of that property. Of course, the value that we are after is the *true cash value.* This term has been misunderstood to a considerable extent. What is the true cash value of this property? I might ask, what is the true cash value of any property? And perhaps I had better come to the consideration of the question that is of most importance to you—what is the true cash value of your property? For I am to speak along the lines of the letter of your President, wherein he asked me to talk to you of the true cash value and how to arrive at the cash values of your properties. I do not believe I can enlighten you very much how to get at the true cash value of your property. If you gentlemen do not know the true cash value of your properties no one else does. The statute has been read to you, and it is the *sale* value of your properties. Suppose it was desired to purchase a gas company, and suppose another party desired to sell one; then you must first agree on what is the value of that property, and you finally do come to an agreement as to the value. That is the cash value of it. That is the sale value. That is where the minds of the buyer and seller meet. That is true, not only as to these properties, but as to all properties in the State. True, an assessor may not always agree with you.

Of course, if one company should be forced to sell, another company might get hold of the property at an exceedingly low figure, and this would not represent true value; but it is that value, gentlemen, where the minds of the buyer and seller meet, one desiring to sell, and the other to buy, the seller not being forced to sell.

Now, then, another thought is suggested by another letter from your President, as to what elements would be taken into consideration in arriving at a true cash value, other than the physical value of the property. What elements? All elements that make or unmake values. It is exactly as if you were buying a horse. It is not the value of the horse's hide, nor the mane, nor the tail alone, but you take everything into consideration; finally the physical horse appears before you. All horses are not alike. Then you begin to consider the elements—what

is the age of the horse, something like you do when you want to know how long a franchise you have. What is the age of the horse? Is he 5, or is he 25 years? There is an element. What is his breeding? What is his color, oftentimes, if one is particular about that? All these elements enter into the value of that animal, and the elements surrounding gas companies, the entire property and all the attendant surroundings, enter into the value of the company. Now on the physical part you will probably agree. All of you know the price and value of your mains, your pipes, and your retorts, and all those things that are fixed in the markets and settled and you know what they are worth; but there are some other things to consider in buying your property. Why, don't you believe that a gas company is worth more situated in Kalamazoo than it is up in the county of Roscommon, in the woods, with the same physical properties? You may be sure it is. You consider the fact of the population of the city of Kalamazoo; notwithstanding the fact that the same physical properties may exist in Roscommon. I am making the comparison to illustrate by extreme conditions. So you would consider whether these properties were situated in Kalamazoo, or in a place of 2,000 inhabitants. You would take that into consideration. Another element that you would take into consideration in Kalamazoo, is how long can you remain in the streets of Kalamazoo and do business? What rights have you there? If you have no rights, or if your rights could be interfered with in a short time, you would take that into consideration. But if the rights were established and settled to do business for a long time, you would consider that, and be compelled to before you bought the property. Those are franchise rights. Now let us not get mixed upon this matter of franchises. It is a simple matter. It is one of the elements only and enters into the value. Something as we consider location enters into the value of property, by considering it and not valuing it, as such. If you had no franchise, I say to you, that you would not regard the property of the same value as if your company had a good franchise. So that is one of the elements to consider. And I undertake to say that everyone of you gentlemen would consider and weigh these elements when buying and selling these properties, and you would note and consider every element that entered into the value. You would not miss any of them. You are sharp, shrewd business men enough to look into all the elements that go to make or unmake the value of property. And while the definition that your President read from the tax law as to true cash value is pertinent and controlling, the latter part of that section is very pertinent to me. In arriving at the true value of property, you will consider what? You will consider the location of the property. You will consider—if it is such a property—the fact that it has a water power privilege, the deposit of the mineral wealth, possibly, and all the other elements. The word "franchise" is not used in that section, but our Supreme Court, in the Detroit Street Railway case, determined that and read it in as well, for it was already really there by intent of the Legislature. As I said to you, you are to consider everything that goes tb make value. And, therefore, you will consider the *franchise* as one of the elements of value.

Of course, this subject of taxation is a broad one, and it is made to cover every line of property in the State of Michigan under the existing theory of which I have spoken. Your companies form an important property of the State. No doubt you feel at times, as your President today has expressed himself, that taxation in Detroit is burdensome, and possibly the Tax Commission or someone ought to be attacked for that reason; but it is existing for the same reasons with all the property that goes onto the rolls. But there is a root of evil in this State, and if it exists in Detroit that is of more importance. In this connection I will say to the gas companies of Michigan that the assessment of properties at their honest value is not the root of evil, but that rather it is the appropriations for the budgets that are being made up all through this State, and which the law of assessment and taxation must operate to pay. Is there anything wrong, gentlemen, in having your property listed upon the rolls of this State and assessed at its true value, the amount for which you could sell, or someone would pay? No, nothing whatever, you will admit, provided all the rest of the properties are to be placed there, too. That is the effort of the Commission; to see to it that all properties shall be so listed and valued. But if, by allowing administrative budgets to be made up in an extravagant way, why you can wipe out all the good work the Tax Commission can do.

The people of this State should wake up to the idea that extravagance must cease. Now, let me illustrate that to you. Two years ago the budget that was made up in this State, in round numbers, amounted to $20,000,000. The budget, as made up this year, in round numbers, aggregates $23,000,000, including highway labor tax, or something over $22,000,000 without this tax. I am speaking now of the State, county, town, village and city government; there are the total budgets, Now, your properties must be assessed right, and, of course, your taxes will be higher if they keep increasing the budgets in amount. That follows. I am aware also of a feeling in this State that lays the blame to the State administration; that they must have a change in the administration of the State, because the taxes are growing higher and higher all the while. Now, if you will look at the amount, it may interest you to observe the different amounts that make up these total budgets. The State tax for 1899, of this total of $20,000,000, was some over $3,000,000; about the same in 1900, a little less, because that was the odd year, when expenses always decrease somewhat; 1901, again a little over $3,000,000, about the same as 1899; but this coming year the State tax will be less than $2,000,000. But what makes up these great sums? It is the towns, aggregating to the immense amount of $5,286,000, and the cities, $8,377,000 in 1899, and in 1901 the cities have exceeded $9,000,000, while in 1899 the cities were in the $8,000,000 column. But you will see that the State tax for 1902 is less than it has been for the last 3 years; but the total amount is 2 or 3 millions more. So I say the people are making a mistake in this State in saying that it is the State tax that is causing the burden.

It is made up in your cities and your towns. Why, modern life is requiring everything that is in sight; there is nothing but what the people want, and as they are going to have it it must be paid for; and your gas companies representing the immense values of property that hey do in the State, must help to pay for it in proportion that they appear assessed upon the rolls. I say to you, gentlemen, it is not the law of assessment admittedly just that is creating this burden, it is rather the amount required to be raised. The people of this State ought to be satisfied to allow their properties to go to the rolls at this one uniform standard of value, and that value is the value for which you can sell that property, what a buyer will pay for it. And in making up the total of that value, to repeat, both the buyer and the seller consider every element that goes to make value; and in making up the value of a gas company we are to consider every attending element that, with the property, is being bought and sold that tends to make or unmake the value of the property. Then if there is good cause for complaint, wage war against the source of the trouble.

Now, gentlemen, I do not know that I can, to advantage, speak further upon this proposition. Perhaps I have said enough that some discussion may ensue along these lines. I shall be glad to answer any questions to bring out what I have not made clear, or to discuss with you in an informal way the general features of our tax laws. [Applause.]

Fuel Oil.

[A Paper read by Mr. W. W. Reed, of Houston, Tex., at the Fourth Annual Meeting of the Southwestern Gas, Electric and Street Railway Association.]

The subject "Fuel Oil" is such a broad one that I shall limit myself in this brief paper to the commercial side of the question, and the utilization of oil as fuel for steam purposes.

The discovery of oil at Beaumont, Tex., in such apparently inexhaustible quantities should, and doubtless will, mark the opening of a new era of employment for Texas and the Southwest. With such a cheap fuel at our very doors the immense advantages to manufacturing enterprises must be clearly seen. The fuel problem being solved, why should the raw material which we produce in such vast quantities be shipped to Northern manufacturing centers, to be converted into manufacturer's products? The discovery of oil in California has had a remarkable effect upon the growth of industries in that State, and there is no reason why their experience should not be repeated here, only in a larger measure.

Fuel oil has already displaced in a large measure the use of coal in many sections of this State. The immense saving to be accomplished over the use of coal will in a short time pay for the investment of the fuel oil burning equipment, and while oil will never entirely replace the use of coal, its use in this section of the country will be very extended.

Oil makes an ideal fuel. Aside from its low cost, there are many other advantages to be gained by its use. In the first place, it is more easily handled than coal or wood, and its use cuts down in a large measure the amount of labor necessary to be employed. Probably one of the best equipped fuel oil burning plants in Texas is the one at the plant of the Houston Lighting and Power Company, and a brief description of the plant may be of interest to those who are not familiar with the use of oil as fuel.

Oil is delivered on the spur track in front of the plant in oil tanks of from about 6,000 to 9,000 gallons capacity. It is unloaded by gravity into the storage tanks. There are 3 steel tanks, of 12,000 gallons capacity each. These tanks are situated in an underground, waterproof brick vault, over which is a galvanized iron roof. The storage tanks are provided with heating coils to heat the oil in cold weather, so that it will not become too viscous to flow freely and be handled by the pumps. The oil is pumped from the storage tanks into a small receiver, where it is heated to a high temperature by the exhaust steam from the pump. It is then forced to the burners under pressure, the pump being automatic in its action, maintaining a constant pressure of oil, no matter how much oil is being used. In the oil feed line is an oil meter which registers the amount of oil consumed. After the oil gets to the burner its action depends, of course, on the style of the burner. The general principles of all oil burners are about the same. Before coming to the nozzle of the burner, the oil comes into contact with the live steam from the boilers, the steam, of course, expanding and atomizing the oil. In some burners the atomization of the oil is accomplished in the burner itself, while in others, it is practically atomized in the firebox. The former method seems the better.

Relative Heat Values of Coal and Oil.—In comparing the heat values of various fuels the number of heat units contained in each is, of course, the proper and scientific method of comparison. Professor Phillips gives in his report on "Texas Petroleum" the following values: For petroleum he gives from 17,000 to 20,000 B.T.U., and assumes an average value of 18,500 B.T.U.; for the Alabama coals he gives 13,500 B.T.U.; good McAlester coal, 13,500 B.T.U.; New Mexico coal, 12,000 B.T.U.; and lignite, 9,900 B.T.U. On this basis 1 barrel of crude petroleum, weighing 320 pounds net, would be equivalent to 438 pounds of Alabama or McAlester coal, 492 pounds New Mexico coal, and 598 pounds of lignite.

From these values, then, a calculated number of barrels of oil to equal one ton of coal would be:

1 ton Alabama coal	4.56	barrels	oil.
1 " McAlester coal	4.56	"	"
1 " New Mexico coal	4.06	"	"
1 " Lignite	3.34	"	"

In actual practice the value of oil as compared with coal would vary, depending on many factors, such as the grade of coal, efficiency of the burner or atomizer, furnace construction, etc. Results based on actual practice are from 2½ to 4 barrels of oil to a ton of soft coal.

Reduction in Cost of Handling Fuel Oil Over Coal.—In using fuel oil the cost of handling the fuel is greatly reduced. The oil is usually unloaded by gravity, thus doing away with the cost of unloading coal. The oil being fed automatically to the furnaces, the stokers and coal passers may be done away with. All that is necessary is one man in the fire room to look after the water level and keep track of the general operation of the system. While no great amount of skill is required to operate an oil burning system, a great deal depends on the careful adjustment of the burners, insuring a proper amount of steam and air supply for the oil being consumed. What is known as a "gas flame," a blue, or whitish blue, transparent flame, which completely fills the firebox, gives the best results.

Increased Steaming Capacity of Boilers Using Fuel Oil.—The use of fuel oil increases the steaming capacity of boilers in the neighborhood of 35 per cent. At the plant of the Houston Lighting and Power Company, with a certain load on the generators, one boiler using oil now does easily that which formerly required two boilers using coal.

Cleanliness and Safety.—In using fuel oil the boiler room and premises can be kept tidy and clean, as there is no unsightly coal pile, no dust, ashes or clinkers.

Insurance companies will not allow a gravity system of feeding the burners, so that there is no oil above the level of the burners. Recent fires, so near to the oil tanks that this oil was heated to a very high temperature, have shown that there is little or no danger to be feared on that score, as the oil did not explode, or even ignite and burn.

Other Advantages.—Other advantages that may be mentioned are these: The fires may be regulated from a low to an intense heat in a very short space of time. The firebox with proper use of oil will last a great deal longer than with the use of coal, and there are no repairs and maintenance of fire tools. The fire doors not having to be opened, cold air is not suddenly admitted into the combustion chamber to cool down the gases, and cause unequal expansion and contraction of the tubes and boiler sheets, with the consequent deterioration of the same.

Results of Tests.—It was my intention in preparing this paper to obtain, if possible, the experience of some of the concerns who have been using fuel oil, but sickness prevented me from getting this data. I will have to confine myself, therefore, principally to the experience of the Company with which I am connected.

I know personally of but two evaporation tests made with the Beaumont oil. One of these was made by the Houston Electric Company. The test was made on two Babcock and Wilcox boilers, and an evaporation of 13.48 pounds of water per pound of oil was obtained from and at 212° F. The oil was found to weigh 7.43 pounds per gallon.

The other was made at the plant of the Houston Water Company, where an evaporation of 14.71 pounds of water per pound of oil was obtained from and at 212° F.

We have never made any evaporative tests at our plant, and in this connection I might say that an evaporative test is not a fair one, so far as actual results are concerned, unless the steam used to operate the atomizers is deducted from the amount of water evaporated. This is particularly so where 2 burners are to be compared, for manifestly if two different burners give the same evaporation per pound or gallon of oil, the one using the least steam to operate it would be the best.

From data covering a period of 2 months' use of coal and 2 months' use of oil at the plant of the Houston Lighting and Power Company, the following results were obtained:

The number of kw. hours produced at the switchboard from 1 ton of Montreal "mine run" coal, as compared with the number kw. hours produced from 1 barrel of Beaumont crude oil, showed that 1 ton of coal was equal to 3.60 barrels of oil.

A number of tests were also made to determine the relative efficiencies of various forms of burners. Of course in a paper of this kind I am not at liberty to disclose the names of the various burners, but will designate them by numbers. Efficiencies were taken in gallons of oil consumed per kw. hours output at the switchboard. This method is in some respects not an ideal one, since it takes into consideration the efficiencies of the steam and electrical machinery. The conditions governing the tests were, however, as nearly as possible, the same in all tests; *i. e.*, with the same condition of boilers as to cleanliness, and the same load on the engines and generators, the tests all covering the same length of time.

The efficiencies obtained were as follows:

Burner No. 1	.713	gallons	per K.	W. H.
" " 2	.667	"	"	"
" " 3	.606	"	"	"
" " 4	.575	"	"	"

It will be seen from this that burner No. 2 affected a saving of 6.4 per cent. over No. 1; No. 3, a saving of 15 per cent. over No. 1; and No. 4 a saving of 19.3 per cent. over No 1, showing that a great deal depends upon the construction of the burner.

The high efficiency of No. 4 burner is due, I believe, to a device in the burner whereby the oil and steam are very intimately mixed, and also to the fact that highly superheated steam is employed to atomize the oil, thus bringing the mixture up to a very high temperature. The flame produced is a very uniform "gas flame," and the nozzle of the burner is so proportioned that the flame completely fills the firebox. Our experience has also shown that a great deal depends upon the construction of the firebox. Of course, a construction that is suitable for one class of boilers would not suit another class. I believe that in installing a fuel oil equipment various arrangements of firebox construction and burners should be tried, and the arrangement best suited to the requirements determined by experience. Where the grate bars, as arranged for burning coal, are left in place and covered over with a layer of firebrick, the furnace can be adapted for the use of coal again in a few minutes' time in case the supply of oil runs out, or in case of any serious accident to the fuel oil burning system. By using this construction the air is also heated in passing through the hot bricks and the temperature of the gases not cooled down. The necessary amount of air for complete combustion can be regulated by opening or closing the ashpit doors.

Sulphur in Fuel Oil.—When fuel oil from the Beaumont fields first began to be used for steam purposes, much was said about the destructive effects of sulphur in the oil. It was claimed that the large content of sulphur in the oil would in a short time injure and ruin the tubes and sheets of the boilers. I presume the "Coal Kings" were responsible for these reports, but time has proven that there is nothing to fear on this score. The percentage of sulphur in Beaumont oil is placed by analysis of various parties from 1.33 per cent. (Dr. Redwood, Beaumont Oil Review, March 20, 1902) to 2.04 per cent. (analysis of A. M. Smoot, Chief Chemist of Ledoux and Company), and after using Beaumont oil for a period of over 10 months I have been unable to detect any injurious effects on our boilers, due to the presence of sulphur.

Saving to be Effected by the Use of Oil.—Knowing or assuming the relative value of coal and oil, and knowing the cost of coal and oil delivered at the plant, the saving to be effected by the use of oil can be calculated. The saving found at the plant of the Houston Lighting and Power Company was about 63 per cent. Oil fuel requires less labor in handling, as the oil is usually unloaded from the tank cars by gravity and fed to the burners automatically. This does away with the labor of unloading the coal and the labor of coal passers.

The deterioration of the furnaces is less with oil than with coal, and as with proper firing there is no smoke or soot with the use of coal, the tubes of the boilers are cleaner, thus allowing more heat to be taken up by the water.

The maintenance charges with a fuel oil equipment are less than with coal.

Crude oil has so many advantages over coal as a fuel that it seems destined to eventually almost displace the use of coal for industrial purposes in the South and Southwest, and in fact any section where it can compete with coal. Already a large number of railroad companies are using oil fuel on their locomotives in this section, with apparently the best results.

Again regretting that sickness and lack of time have prevented my doing more justice to so important a subject as fuel oil, I will conclude by suggesting that the President call upon the members of the Association who are using fuel oil for the results of their experience.

A Scheme of Ventilation with Gas Warmed Air.[1]

The popularity of gas lighting for public halls, churches and places of public resort, generally is tightly bound up with the provision of adequate and comfortable ventilation. The imaginary superior heathfulness to gas of electric light, based on the indubitable fact that it is not a light of combustion, is always the main argument of electricians, and is the sole setoff which they are able to adduce against the higher cost of electricity as compared with gas lighting. It would be a blunder for gas engineers to underrate this argument, which, indeed, always carries much weight, and possesses a certain foundation in fact which renders the excessive inductions usually drawn from it for commercial purposes extremely difficult to combat in the interests of common sense and economy. Without doubt, there are interiors and circumstances where the incandescent electric lamp is a great luxury—like the ability to have a fire in one's bed and bath room during cold weather; and those who are able to afford it will always do so. They would be very foolish if they did not. But these are not the places or the circumstances that very greatly matter, from the business standpoint, to the suppliers of either gas or electricity for lighting. The really important truth is, that for all interior lighting on a large scale, the necessity of proper ventilation for the sake of the health of the inmates is not materially affected by the selection of the means of lighting.

We would not be misunderstood upon this all-important point of hygiene, and therefore will explain that the observation applies only to modern lighting practice of the best kind. Of course, if it is sought to produce a dazzlingly brilliant effect of light by the least suitable means, it is only possible to succeed at all by making the arrangements on such a scale that consequential inconvenience is sure to result. Thus, candles and oil lamps are, and in all probability always will remain, favorite means of lighting some classes of interiors, in a particular way; but if they are overlavishly employed, the effect upon the atmosphere and the temperature of the apartment will be unpleasant and injurious to the occupants. The same remark applies to gas, when burnt in the old fashioned style by means of flat flame burners. The heat of the products of combustion is here a very noticeable accompaniment of the light produced, especially in the case of flat flames disposed horizontally, which used to be so much affected in church and public hall lighting. That is, of course, quite unnecessary. With incandescent gas lighting, whether intensified or at ordinary pressures, the heat of combustion is insignificant in comparison with the lighting effect. The business difficulty lies in getting the people interested to see this. Gas companies have as a rule taken so little interest in the actual use of gas by their customers that the attempt to get into confidential relations with them now, with a pushing rival in the field, very often fails. But the logic of facts is all on the side of gas; and the pressure of the economical consideration is bound to tell in the long run.

Many public halls and churches, and most large shops and warehouses, simply cannot afford a lighting bill several times higher than is absolutely necessary to enable the working to be carried on. If they are prevailed upon to try electric light for a time, they will return to incandescent gas after they have had a chastening experience of the only alternative; but it is preferable that they should not make this excursion at all. With the object of retaining this branch of custom, gas engineers should be able to fight it out with the electricians on the point of ventilation. The point is, briefly, that where any special provision for ventilation is required at all, it is needed as much with incandescent electric lighting as with incandescent gas. That is the position. It is no question of more or less need, but absolutely of the same hygienic requirement. This conclusion, of course, flows from the consideration that interiors are lit in order to be occupied with comfort and health by people, which is a reflection the electricians find it convenient to ignore. "Our light," they say, "does not use up the air." No; but the people do, and it is they who need a proper air supply.

Once get it agreed that an occupied interior needs proper ventilation, however lighted, and the rest is a matter of mechanical engineering. Let nobody run away with the notion that the satisfactory ventilation of a church, or a long shop, is an easy job. On the contrary, it is extremely troublesome, and very difficult; for which reason it is too often left alone. The owners of the establishments that most need ventilation shirk the provision, usually by the adoption of various and sundry palliatives. Electric lighting is one expedient; forbidding smoking is another.

But if a hygienic inspection were made of the atmosphere (say) of the inmost recesses of a busy, unventilated draper's shop in any town 3 hours after the electric light had been switched on, the result would be appalling to those who would persuade themselves that, because atmospheric impurity cannot be seen, it does not exist. And any one who next morning enters a church much used on Sunday, needs no chemical analysis to inform him that there is something very wrong with the atmosphere.

For practical purposes, the efficient ventilation of an interior means that its atmosphere shall be changed with sufficient frequency to preserve a tolerable degree of freshness. There would be little difficulty about securing this desideratum, but for the equally binding requirement that the work must be done insensibly, whether as regards the movement of the air or its temperature. This obligation makes all the difference. Hence, follows the necessity of combining ventilation with warming. By whatsoever arrangement the changing of the air is effected, the correction of the inflowing air to the desired temperature whenever it happens to be too cold, must be provided for. It is obviously impossible to discuss here the multiplicity of the problems of ventilation that, with knowledge and ingenuity, it is possible to solve more or less completely for practical purposes by relying upon what is called natural ventilation. We speak of solving these problems partially, and regard this qualification as important; for it is one of the commonest and greatest mistakes in ventilation to overdo it. Snugness in cold weather is a highly prized quality of all interiors; and where it has been jeopardized by too liberal ventilation (installed by someone who does not live in the place) it is usual to find the air openings pasted over, and intended air valves broken down.

Experience shows, however, that for many of the most pressing cases of bad ventilation, mechanical means of moving the air are indispensable. It has been found that most existing large buildings, where provision has been made for moving the air by the direct application of heat—whether of steam, gas or coal—to expand the effluent air in rising eduction conduits, do not give uniform satisfaction in this respect. Such a means of moving air is to be ranked as old-fashioned; and it is far more costly than mechanical driving or exhaustion. It does not matter to a fan or blower whether it is driving or exhausting; but it makes a good deal of difference to the scheme of mechanical ventilation, by reason of the connection with warming. Consequently, ventilating engineers are in the habit of distinguishing systems of ventilation as the "plenum" or the "vacuum" systems, accordingly as the air is driven in or exhausted out of the interior in question. This distinction must not be pushed pedantically. In everyday experience, in the English climate, it is found more convenient to blow fresh air into a hall, leaving means for its escape after it has served its object.

Where an apartment, such as a church, can be ventilated directly by the application of a fan to its particular needs, this is the most expedient treatment to adopt, as has been proved in the Law Courts, and in the Committee Rooms of the Houses of Parliament. There are many halls where the obvious working of a fan in the window is not objectionable; but where this cannot be borne with, a fan chamber with conduits must be provided. It is the same when collective ventilation has to be resorted to. In large buildings containing many rooms, the multiplication of fans would mean unnecessary expense and after maintenance.

1. *Journal of Gas Lighting.*

Here a good gas engine, with a blower drawing air from the roof, would answer the purpose. Positive blowers are unsuitable for this class of work, as there is no air circulation through them if the machinery breaks down. For small, independent room fans, electric driving is most convenient, although a small hot air engine, working with gas, will serve instead. A very serious difficulty in many cases arises in connection with the warming of the inflowing air. This is best discharged into the interior at about the height of the occupiers' heads, and should sweep right through or across the inclosed space to the outlets. In order to have the necessary velocity of travel, the air should be driven in with considerable force—preferably through converging conical nozzles—exactly like fire nozzles.

Where the contrary form is given to the inlets, the air enters without velocity, and simply falls down in a shower immediately inside the walls. Of course, in order to prevent the feeling of a cold draught of air, it must be warmed sufficiently—say, to 56°. This cannot usually be done from the hot water heating apparatus of the building, which is not commonly carried so high as the fresh air inlets ought to be placed.

Something might easily be done in this way by gas heating arrangements, in which the air should pass in contact with plates or pipes warmed locally by a gas flame. A fresh air supply of 15 cubic feet per minute per head is a very fair allowance for most public buildings, including schools. The specific heat of air at constant pressure is about 0.24, which is equivalent to 0.01817 unit per cubic foot. The number of units of heat necessary to warm 15 cubic feet from (say) 32° to 54°, or by 22°, is consequently 15 × 22 × 0.01817 = 6 nearly. Assuming the calorific power of common coal gas to be 600 units per cubic foot, and that an air warming stove would have an efficiency of 50 per cent., this means that a stove burning 1 cubic foot of gas a minute would warm the air for 50 people, and might possibly do even higher duty. Inasmuch as the other heating apparatus might be shut down as soon as this warmed air supply was started the cost of the latter would not be great, even during a frost. Usually, in our climate, the demand would be less than this. It would be interesting to hear of such an arrangement being tried.

The Haltzer-Cabot Gas Engine Igniter.

Iron Age says that the Haltzer-Cabot Electric Company, of Boston, Mass., has recently designed and placed upon the market a new gas engine igniter of the dynamo type, which presents some novel and distinctive features, the most important of which are found in the fact that it does not require the use of a spark coil and is quite independent of speed, the latter feature overcoming the great objection to the dynamo type of igniter.

There have been of late great advances made in the size of gas and gasoline engines, while the best practice seems to incline toward the multiple cylinder. These engines, by reason of the nature and volume of the body of gas to be ignited, the high frequency of the spark, and also on account of pecularities in the construction of the make and break device, require a large and practically continuous flow of current to produce satisfactory ignition.

It is well known that the strength of magnetization obtainable in the best permanent magnets is for a given weight relatively quite small in comparison with that which may be secured with an electro magnet. It is evident, then, that a machine of the permanent magnet type constructed to deliver any considerable amount of energy would be unnecessarily large and heavy. This igniter has been, therefore, made of the dynamo type for the reasons given. It weighs 19 pounds and will, if necessary, deliver continuously a maximum output of 50 watts. As stated, the dynamo is practically independent of speed, and at 1,000 revolutions per minute will deliver ample current for satisfactory ignition, while the speed may be increased to 2,500 revolutions per minute without any danger from burning out. Thus the igniter may be driven from the flywheel of the engine with the ordinary belt or friction pulley.

The field core is a solid casting of soft steel, and the armature is of the drum type, carefully laminated and wound with double silk covered magnet wire. The shaft is of high grade steel and the bearing sleeves are of phosphor bronze. The brush holders and commutator are large and heavy, while the brushes are of a special composite structure, combining the substantial qualities of carbon with the higher conductivity of the copper. The machine is rendered quite impervious to dust and moisture by a protecting shield, which fits over the commutator and brushes. This may be easily removed, making the brushes and commutator readily accessible. The body of the machine is mounted on a light hinged base in such a manner that a wide range of adjustment may be effected without using sliding contacts or clamping nuts.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. Henry C. Slaney has been appointed Superintendent of the Equity branch of the Brooklyn Union Gas Company, of Brooklyn, N. Y. It is a well deserved promotion, and that clever gentleman may be counted on to do effective work in his new position.

The Suburban Electric Light and Power Company is proposing to establish a gas lighting system in Haywards, Cal.

Manager Poingdestre says that the new plant for Grass Valley, Cal., will be in active operation by the 1st prox.

The proprietors of the Brookline (Mass.) Gas Light Company have authorized the placing, in the electric division of their plant, at Allston, of a 250-horse power Hazelton boiler. This, when installed, will make a plant of 1,000-horse power of the Hazelton type in the Brookline works.

On the 22d inst. application will be made to the Governor of Pennsylvania for a charter for the Tiadaghton Gas Company, the promoters of which propose to manufacture and supply gas to the residents of Pine Creek township, Pa. The incorporators are Messrs. H. T. Harvey, John M. Reilly, John H. McCormick, James A. Pugh and Seth T. McCormick. We should not think that an artificial gas works would be able to exist on the business that it could secure in the township named.

The Fox River (Wis.) Valley Gas and Electric Company will completely rebuild the gas and electric plants owned by it in Neenah.

At the annual meeting of the old Chester (Pa.) Gas Company the following Directors were elected: Samuel A. Crozer, Stephen Cloud, Jr., J. Howard Roop, Clarence Deshong and E. Barton Johnson.

At the annual meeting of the United Gas Improvement Company, held in Philadelphia last Monday, the proceedings whereof were under the direction of Mr. George H. Earle, no change was made in the Board of Directors. The capital stock of the Company was increased to $28,250,000. The increase, of 115,000 shares of common stock, is offered to the stockholders of record at the close of the business on May 10th at the par value of $50 per share, in the proportion of 25 per cent. of their holdings. The privilege to exercise this subscription remains open until June 15th. The method of allotting the new stock was decided according to the following resolutions, which were unanimously adopted:

"Negotiable certificates of allotment will be issued to stockholders of record at close of business May 10, and mailed to them on May 16. When subscription has been made on or before June 15, and allotment certificate surrendered for cancellation, negotiable certificates of subscription will be issued in lieu thereof, except that when payment in full is made, with the proper interest adjustment, at time of such subscription, a certificate of stock will be issued. The Company reserves the right to refuse to accept any subscription not accompanied by surrender of the allotment certificate for cancellation.

"Subscriptions for the new stock are payable in cash at the office of the Company at the following times and in the following amounts: May 31, June 30, September 1, October 1, 1902, $12.50 per share each.

"Installment receipts will be made by the Treasurer upon certificate of subscription as installments are paid, bearing interest at the rate of 5 per cent. per annum from the date of their respective payments, to September 30, after which date no interest shall accrue upon installment receipts which shall be exchangeable on and after October 16 for certificates of stock." The money from the sale of the new stock will be used to clear off all direct indebtedness and to enlarge and improve plants. The President's report showed the net profits for 1901, all derived from the regular operating business of the Company, to be $2,535,288.84, an increase of $820,941.05 over the previous year. The report also set forth the history of the contract made for the delivery of Texas petroleum at Marcus Hook, to be used in the manufacture of gas. The contract calls for 1,250,000 barrels per annum for 5 years from the date of the first delivery.

The affairs of the Denver (Col.) Gas and Electric Company have been placed in the hands of a Receiver. The latter is Mr. Henry L. Doherty,

who has had much to do with the management of the Company for some time back.

MR. JOHN A. BRITTON, of Oakland, Cal., has been appointed Consulting Engineer by the United Gas and Electric Company, of San Francisco, Cal., in connection with the project of the latter to build and operate a high pressure main for the transmission of artificial gas between San Jose and San Mateo, Cal., a distance of 32 miles.

MR. R. A. FIELDS has been appointed Superintendent of the Rome (N. Y.) Gas, Electric Light and Power Company, vice Mr. J. C. Sloan, resigned. As heretofore stated in the JOURNAL, Mr. Sloan left Rome in order to take charge of the various plants controlled by the J. T. Lynn syndicate, of Detroit, Mich.

MR. JOHN H. DILKS, formerly General Manager of the Indiana Natural and Illuminating Gas Company, died in Indianapolis, Ind., the morning of the 2d inst. He was in his 66th year.

THE Wilmington Gas Light Company, the Wilmington Seacoast Railway Company and the Wilmington Street Railway Company, all of Wilmington, N. C., have been formally merged into a corporation known as the Consolidated Railways, Light and Power Company. Mr. Hugh McRae remains as the chief executive officer of the succeeding corporation.

THE Massachusetts House of Representatives has rejected the bill which sought to provide for annual investigations by the Board of Gas and Electric Light Commissioners of the prices at which gas and electricity are furnished throughout the State.

DURING the last week in April articles incorporating the Seneca River Power Company were filed with the Secretary of State of New York. Under the measure the Company is to manufacture gas, electricity and steam for generating light, heat and power to the town of Schroeppel and the village of Phœnix in Oswego county, and to certain villages in Onondaga county. The concern is capitalized in $100,000, and the Directors for the first year are Messrs. Louis W. Emerick, of Fulton, N. Y., and Simon B. Stevens and Robert E. Drake, of Syracuse, N. Y.

THE following letter from Mr. William Cox, of New York, written to the JOURNAL under date of April 29th explains itself:

To the Editors, AMERICAN GAS LIGHT JOURNAL: I have read with much interest the discussion[1] on Mr. F. H. Shelton's paper on "The Distribution of Gas under High Pressure," read at the last meeting of the Ohio Gas Light Association, and, if I may be allowed, would like to say a few words bearing on the same.

The loss of pressure in the case of gas and other *elastic* fluids flowing through pipes with low initial pressure is correctly represented by $\sqrt{p_1}$, as in Pole's formula, but when dealing with such fluids (air, artificial gas and natural gas) where the initial pressure is high, the loss of pressure is represented by $\sqrt{p_1 - p_2}$, in which p_1 is the *absolute* initial pressure in pounds per square inch, and p_2 is the *absolute* terminal pressure in pounds per square inch, the absolute pressure being obtained by adding 14.7 to the gauge pressure. This latter expression has been obtained from numerous experiments made with air and natural gas, and is found to represent more correctly the loss of pressure in the case of elastic fluids. Pole's formula on the other hand is deduced from the general formula used for the flow of water in pipes, this fluid being practically *inelastic*. In this connection I may be allowed perhaps to state that I am now putting on the market a "Computer," similar to my "Gas Flow Computer," but which is designed to give the flow of gas from long pipes, with high initial pressure, the loss of pressure being represented by $\sqrt{p_1 - p_2}$, which is in such cases the correct expression for this loss.

NEWS from Columbus, O., is to the effect that the Senate and House of Representatives of Ohio have passed a bill under which street railway companies may furnish gas for lighting and heating purposes.

THE Cranfield (N. J.) Gas Light Company is extending its mains to and through the nearby settlement of Ripley Manor.

A GAS company required by statute to furnish gas to all persons within a certain distance of its mains, is held, in Smith versus Capital Gas Company, Sacramento, Cal., 54 L. R. A., 769, to have the right to refuse to do so unless the consumer agrees to pay a reasonable rent for a meter, where the value of the gas required by him will not amount to one-sixth of such rent.

1. *Ante*, p. 606.

MR. BENJAMIN LINDSAY, a prominent resident of Pierce, Neb., has applied to the authorities for the right to operate a gas works in the place named.

THE Commission authorized by the last New York State Legislature, to determine the necessity for establishing a State Electrical Laboratory, met in the State Engineer's office on the 28th ult. The Commission is composed of State Engineer Edward A. Bond, Chas. F. Steinmetz, Chief Electrician of the General Electric Company, and Harold W. Buck, Electrician of the Niagara Falls Power Company. The last Legislature appropriated $2,500 for the preliminary expenses of the Commission, which is to report to the next Legislature whether there should be established a State Laboratory to "gauge" electrical currents and provide for an official electrical meter for the measurement of electricity as the gas consumption is now measured. Each of the Commissioners decided to prepare a plan setting forth what he thinks should be done. These separate plans will be considered by the Commission at a meeting set for next Wednesday.

MESSRS. C. W. LYNCH and William Jennings, of Harrisburg, Pa., have disposed of their holdings in the Hagerstown (Md.) Light, Heat and Power Company, to Mr. Samuel B. Loose, of Hagerstown. All of the Company's shares are now owned locally.

MESSRS. A. R. GHOLSON, Z. Smith, Q. C. Atkinson and John Cunningham, Jr., have applied to the authorities for a charter for the Clarksville (Tenn.) Company, capitalized in $50,000. This Company is intended to take over the rights and properties of the old Clarksville Gas Light Company, which the former named gentlemen have recently acquired by purchase from the present owners. The works are to be rebuilt.

THE Providence (R. I.) *Journal*, of the 3d inst., had this to say respecting the status of the Pawtucket (R. I.) Gas Company: "While the formal organization of the new Company, which has secured control of the Pawtucket Gas Company and the Pawtucket Electric Company, will not occur until the day of the annual meeting of the Pawtucket Gas Company in June, it can be officially stated that the new Board of Directors will be composed as follows: Jonathan Chace, Stephen A. Jenks, Darius L. Goff, Frederick W. Easton, Alfred M. Coates, Frank A. Sayles, John A. Arnold, S. R. Bertron and Lyman M. Darling. It will be seen that, with the exception of Mr. Bertron, who is a resident of New York, that the Board is entirely of Rhode Island interests, six being residents of Pawtucket, which confirms the statement made that the combination was effected and consummated by Rhode Island capital."

WRITE to M. H. Treadwell & Co., 95 and 97 Liberty street, N. Y., for copies of their leaflets on the "Tread-Kill Shaking Grate," and on "Engineers' Firing Tools."

THE regular quarterly dividend of 1½ per cent., by the Peoples Gas Light and Coke Company, of Chicago, is payable the 24th inst.

Alternating Current Meters.

The budget of patents of April 15 contained four on alternating current meters, two of which were granted to Franz Schrottke, of Berlin, Germany, and two to Geo. Stern, of Charlottenburg, Germany. The last mentioned patents relate to a new arrangement of actuating the windings of an alternating current meter. As applied to an induction meter, there are two measuring systems, each consisting of two series and one shunt winding, the windings being arranged in co-operative relation to the usual short circuited armature operating a counter. The current windings are so connected and arranged that the resultant of the current fluxes in the 2 systems are displaced in phase from one another by 150°; and the shunt winding is connected and arranged to generate potential fluxes displaced in phase from one another by the same angle, the potential flux of the non-inductive load lagging in one system behind, and the other leading the current flux.

The second patent covers connections such that the displacement of the current is 30° from its impressed e.m.f. The Schrottke patents describe a meter of the induction type, consisting of a 4-pole field surrounding a short circuited armature, which latter actuates a counter. On two opposite poles is a winding in series, with one of the working conductors and also a short circuited secondary winding. On the other 2 poles is a potential or shunt winding, in series with which is an inductance or a condenser.

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Notification Respecting Advertising.—Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

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New York—American News Co. 39 and 41 Chambers St.
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MONDAY, MAY 12, 1902.

The Market for Gas Securities.

There is nothing of moment to chronicle in connection with the trading in local gas shares the past week. Prices, however, were well maintained, although the transactions were comparatively light. Consolidated closed to-day (Friday) at 224 to 224½. A feature of some of the recent transfers is in the fact that certain fairly round lots have come into the possession of strong financial interests that hitherto did not take much notice of gas shares.

Brooklyn Union sold up to 240, on very limited trading, and it was 235 to 240 at the close to-day. The Company will expend quite a sum this season in plant betterments. Another Brooklyn Company that will considerably add to its plant this season is the Kings County Gas and Illuminating Company. The increase in the output of this concern is remarkable, as Engineer Byrne and his men well know. Bay State continues to show some life. Washington (D. C.) gas is again over the 400 mark. Peoples, of Chicago, is in fair demand at steady figures, and Baltimore Consolidated shows no change.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

MAY 12.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	224	224½
Central Union, Bonds, 5's.	3,000,000	1,000	109	110
Equitable Bonds, 6's	1,000,000	1,000	105	
" 1st Con. 5's	2,300,000	1,000	118	120
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	350	..
Municipal Bonds	750,000	.	..	..
New Amsterdam Gas Co.				
Bonds, 5's	11,000,000	1,000	111½	..
Northern Union, Bonds, 5's.	1,250,000	1,000	106	108
New York and East River				
Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	109	111
Richmond Co., S. I.	348,650	50	100	..
" Bonds	100,000	1,000	103	..
Standard	5,000,000	100	130	140
Preferred	5,000,000	100	150	160
Bonds, 1st Mortgage, 5's	1,500,000	1,000	114	117
Yonkers	299,650	500	130	
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	235	240
" " Bonds (5's)	15 000,000	1,000	119	119½
Bay State	50,000,000	50	2⅝	2½
" Income Bonds	2,000,000	1,000	.	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	11	12
" " Bonds, 5's	5,250,000	1,000	85	85¼
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000		
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co.	29,500,000	100	103	104
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	108	109
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	60	65
Preferred	3,026,500	100	84	86
Consumers, Jersey City Bonds	600,090	1,000	102	103
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore	11,000,000	100	71½	72¼
Mortgage, 6's	3,600,000	..	..	115
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
" Con. Mtg. 5's	380,000	1,000	82	83
Consolidated G. & E. Co.'s, Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	.	89
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	852,000	1,000	70	73
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	34	38
Fort Wayne	2,000,000	..	.	.
" Bonds	2,000,000	..	58	63
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	75	80
" Bonds, 6's	2 650,000	..	104¾	107
Jackson Gas Co	250,000	50	73	75
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	89	90
Preferred	2,500,000	100	105	110
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100		60
Bonds	1,000,000	1,000	58	64
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	107½	108½
" 6 per cent. scrip, due 1910	100,000	25	25	87
Montreal, Canada	2,000,000	100	182	184¾
Newark, N. J., Con. Gas Co	6,000,000	..	..	55
Bonds, 6's	4,600,000	..	..	103
New Haven	1,000,000	25	300	325
Nashville Gas Lt. Co.	1,000,000	100	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	103⅜	103¾
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	48	48½
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	92	93
St. Joseph Gas Co.				
" 1st Mtg. 5's	751,000	1,000	95	96½
Syracuse, N. Y.	1,750,000	100	15	17
Bonds	1,612,000	1,000	95½	97½
Washington, D. C	2,600,000	20	400	405
First mortgage 6's	600,000	..	..	..
Western, Milwaukee.				
Bonds, 5's	4,000,000	..	109½	110
Wilmington, Del	600,000	50	232	..

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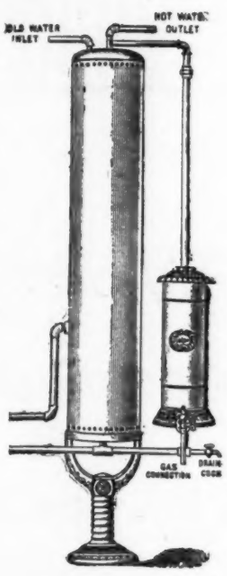

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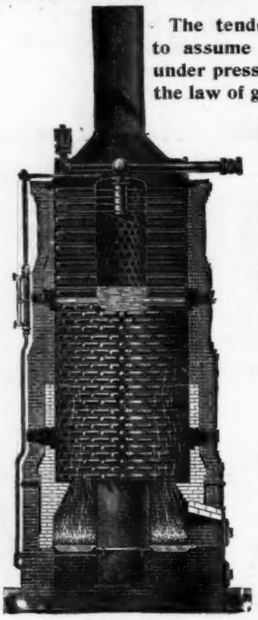

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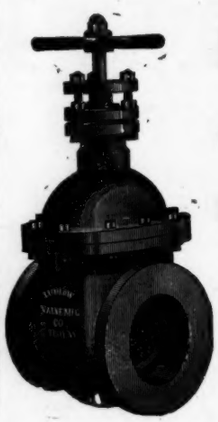

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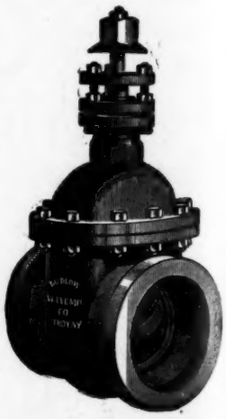

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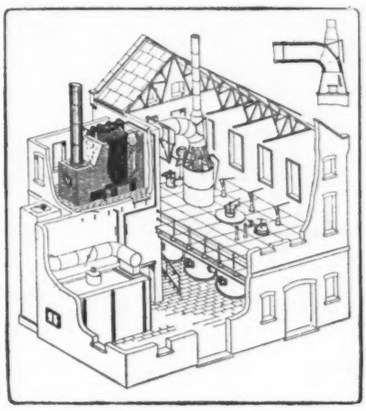

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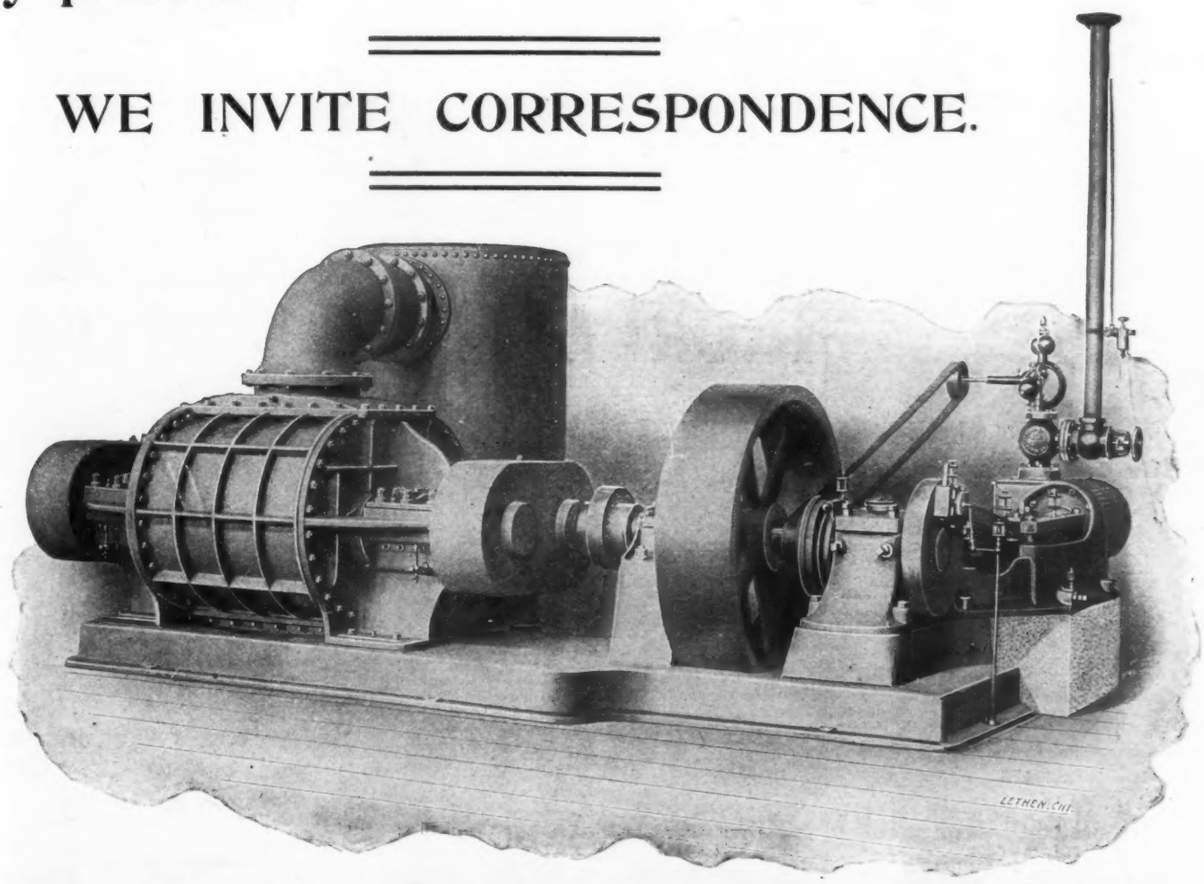

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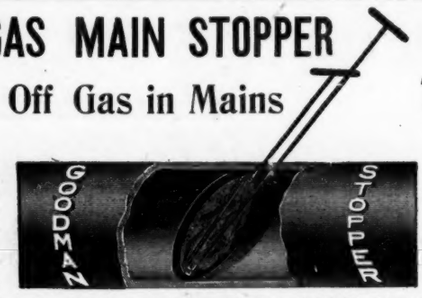

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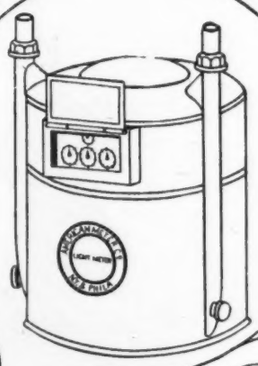

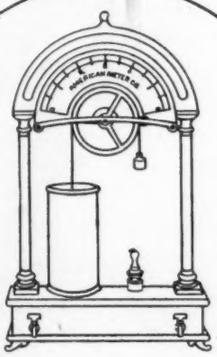

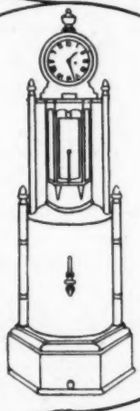

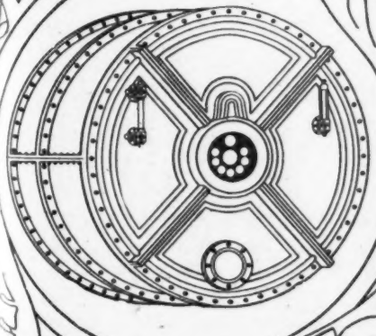

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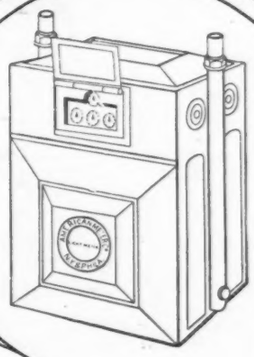
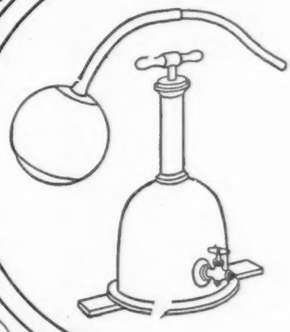
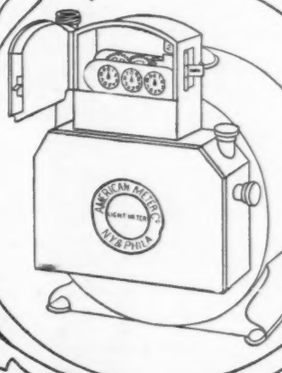






PUBLIC LIGHTING TABLE.

MAY, 1902.

Day of Week.	Date.	Table No. 1. FOLLOWING THE MOON. Light.	Extinguish.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Light.	Extinguish.
				P.M.	A.M.
Thu.	1	7.20 PM	2.40 AM	6.45	4.00
Fri.	2	7.20	3.10	6.45	4.00
Sat.	3	7.20	3.40	6.45	4.00
Sun.	4	7.30	3.50	6.45	4.00
Mon.	5	7.30	3.50	6.45	4.00
Tue.	6	7.30	3.50	6.45	4.00
Wed.	7	7.30 NM	3.50	6.55	3.40
Thu.	8	7.30	3.50	6.55	3.40
Fri.	9	7.30	3.50	6.55	3.40
Sat.	10	7.30	3.50	6.55	3.40
Sun.	11	7.30	3.50	6.55	3.40
Mon.	12	10.50	3.50	6.55	3.40
Tue.	13	11.30	3.50	6.55	3.40
Wed.	14	12.00 FQ	3.50	7.00	3.30
Thu.	15	12.30 AM	3.50	7.00	3.30
Fri.	16	1.00	3.50	7.00	3.30
Sat.	17	1.30	3.50	7.00	3.30
Sun.	18	2.10	3.40	7.00	3.30
Mon.	19	2.40	3.40	7.00	3.30
Tue.	20	No L.	No L.	7.00	3.30
Wed.	21	No L. FM	No L.	7.10	3.15
Thu.	22	No L.	No L.	7.10	3.15
Fri.	23	7.40 PM	9.20 PM	7.10	3.15
Sat.	24	7.40	10.10	7.10	3.15
Sun.	25	7.50	10.50	7.10	3.15
Mon.	26	7.50	11.30	7.10	3.15
Tue.	27	7.50	12.00	7.10	3.15
Wed.	28	7.50	12.40 AM	7.15	3.15
Thu.	29	7.50	1.10	7.15	3.15
Fri.	30	7.50 LQ	1.40	7.15	3.15
Sat.	31	7.50	2.10	7.15	3.15

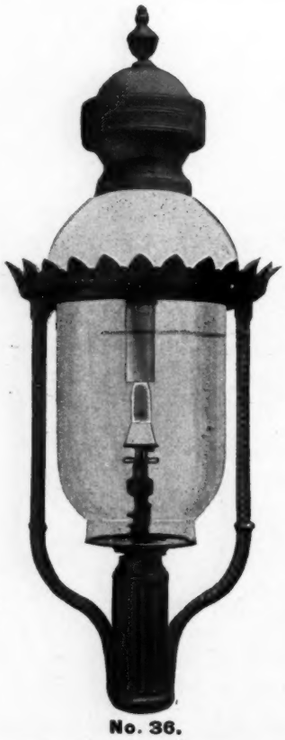
TOTAL HOURS LIGHTING DURING 1902.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	238.30	January	423.20
February	196.20	February	355.25
March	196.20	March	355.35
April	166.40	April	298.50
May	151.40	May	264.50
June	131.10	June	234.25
July	142.40	July	243.45
August	162.00	August	280.25
September	179.00	September	321.15
October	216.30	October	374.30
November	224.10	November	401.40
December	250.00	December	433.45
Total, yr.	2255.00	Total, yr.	3987.45

NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



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By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

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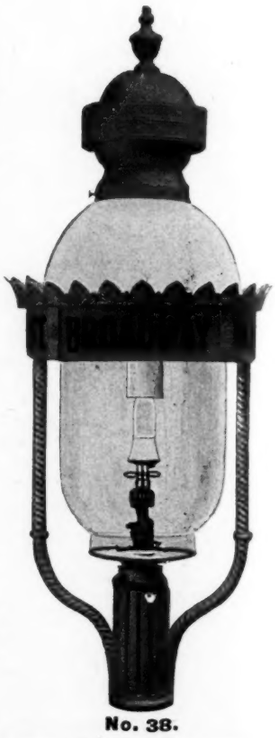
Correspondence Solicited from Gas Companies and Others Interested in Municipal and Outside Lighting.



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The most practical, efficient and artistic burner yet produced. . . . . .

It contains an improved adjustable Bunsen so constructed as to permit of a wide range of variations in gas pressure without blackening the mantles and without an adjustable air shutter. . .

It can be used with all styles and sizes of glassware, either shades or globes. No further necessity to carry a stock of different burners for the many sizes and shapes of glassware.

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THE STANDARD DOUBLE SUPERHEATER

LOWE WATER GAS APPARATUS.

The capacity of apparatus installed, if operated continuously, is sufficient to make more than the entire amount of artificial gas annually sold in the United States.

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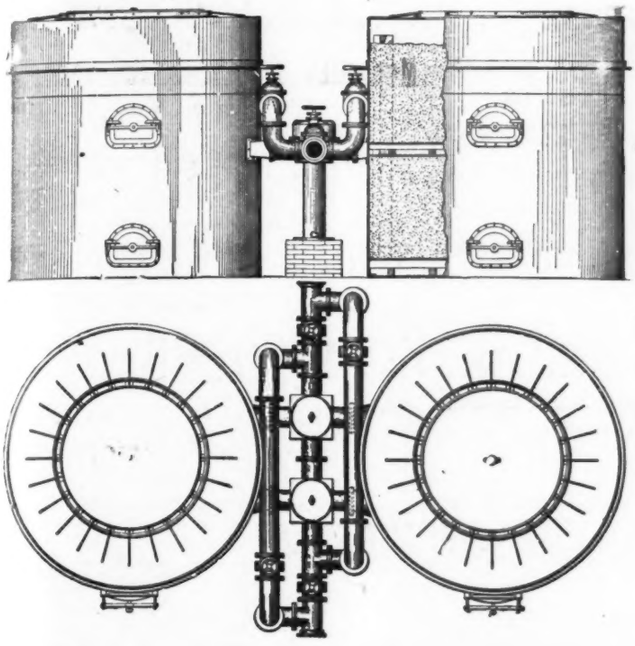

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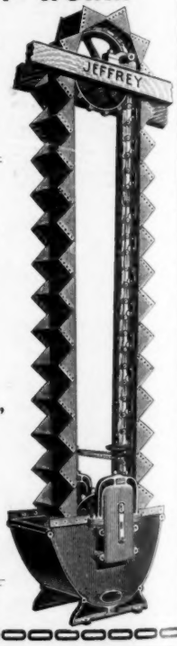

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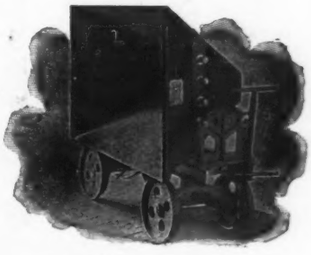

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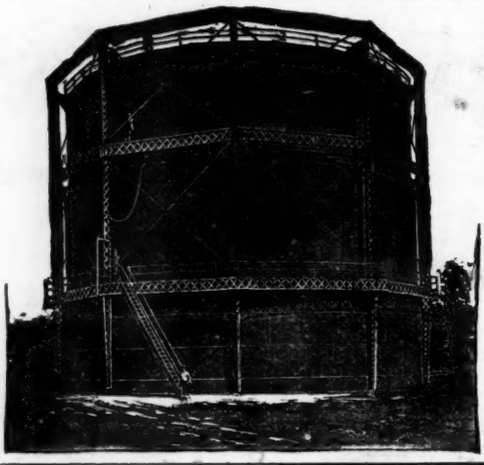

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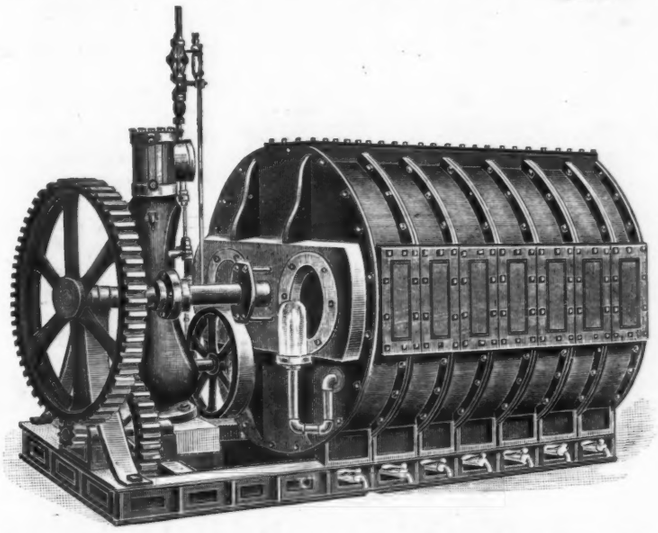

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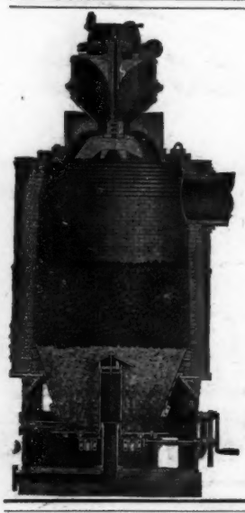

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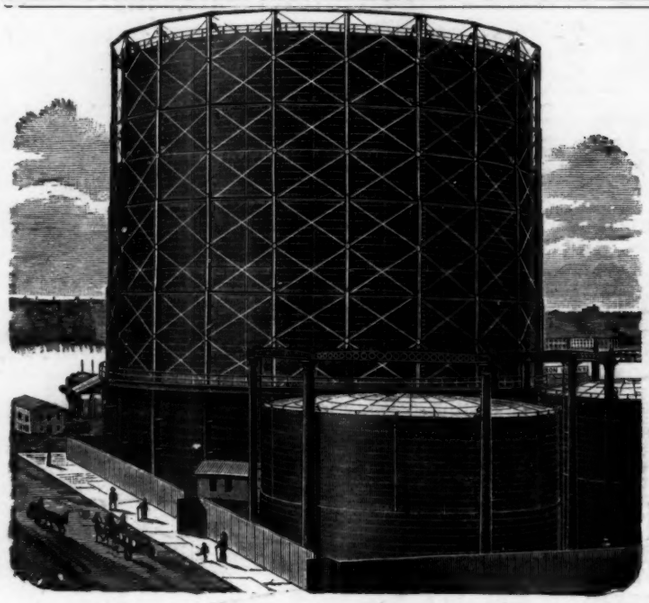

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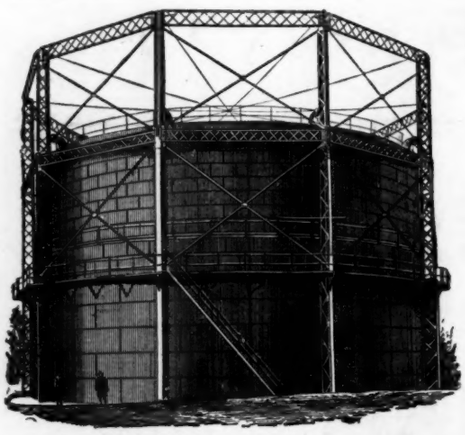

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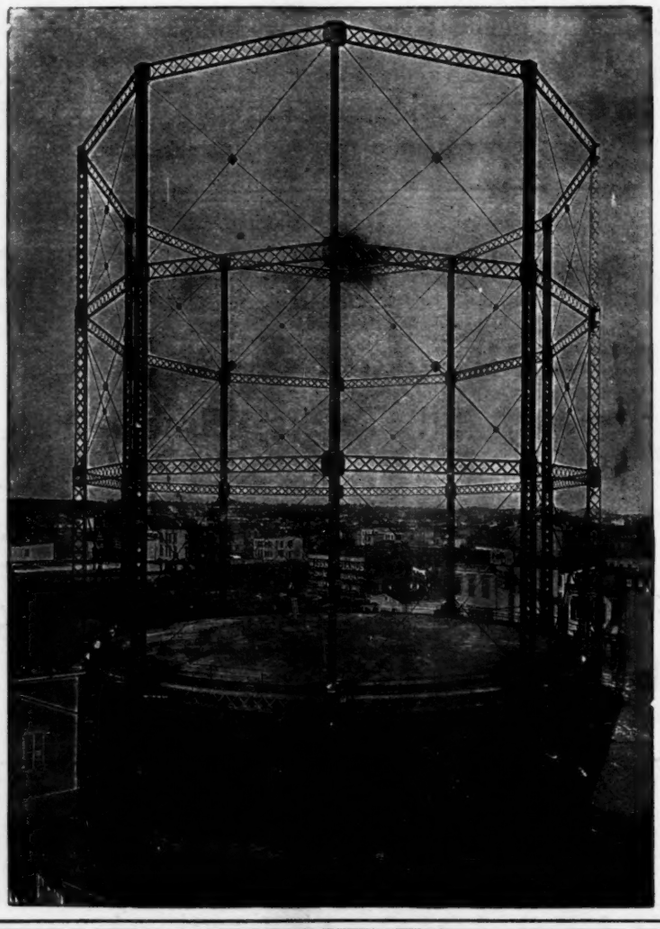

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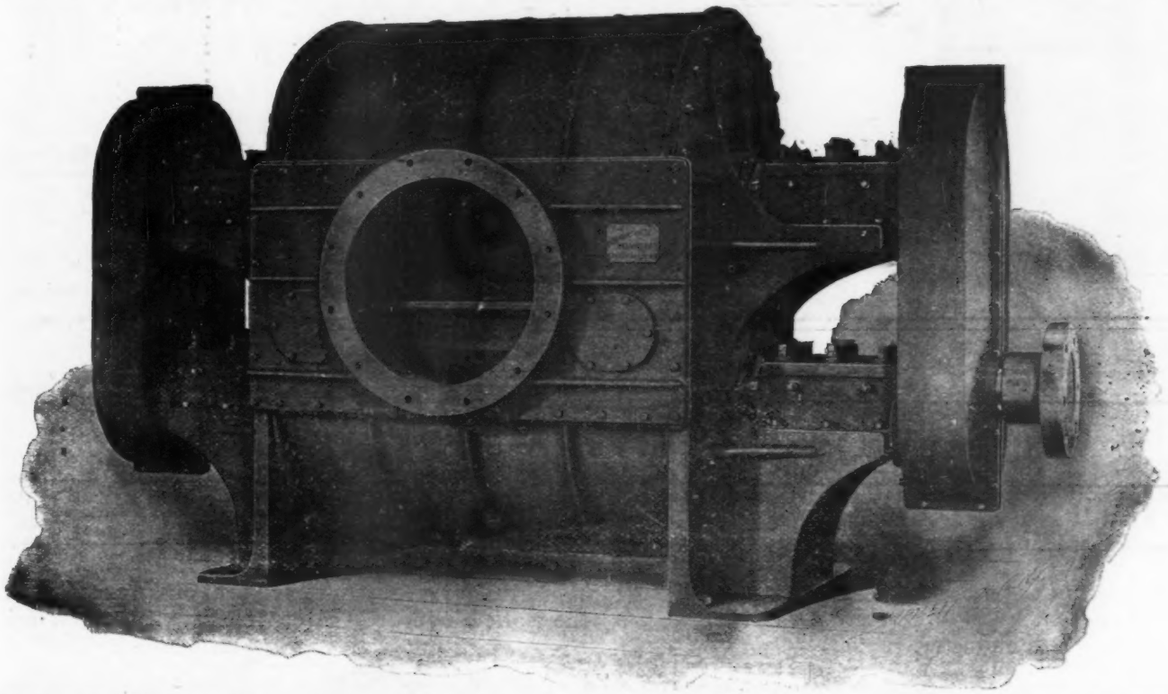

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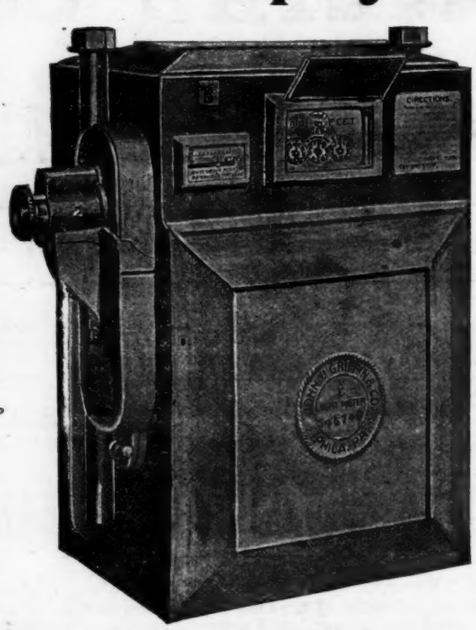

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